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ABSTRACT

The results of a small area forecast with regard to household composition, population and employment distribution, development and school costs, environmental impact, and transportation in Southeast Michigan are evaluated in this report. The role of public policy in influencing the community demography by the year 2000 is considered by demonstrating how different policy alternatives affect patterns of regional development. As an aid to evaluation of the six small area forecast alternatives, three sets of evaluation measures are presented. Public and private costs associated with providing physical facilities to serve new development are analyzed. Measures that indicate how each policy alternative affects environmental quality and natural resources in the region are described. Information concerning how regional transportation systems would be affected under each alternative is provided. Each of the evaluation measures is intended to be used only to compare relative merits of the small area forecast policy alternatives. Evaluation results are provided for the region as a whole, individual counties, and the City of Detroit and by community group classification. The development of community groups, their definition, and a list of the communities that make up each group is appended. (WI)

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ABSTRACT

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ABSTRACT:

This document contains detailed evaluation of the Small Area Forecast results. These acts of policy impacts are evaluated: fiscal impacts, environmental impacts, and impacts affecting the regional transportation system. Individual evaluation measures are presented for each set of policy impacts. Discussion includes background information concerning the formulation of each measure, and analysis of the evaluation results.

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SMALL AREA FORECAST EVALUATION

August 1978

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PREFACE

This document contains the latest information concerning the evaluation of the Small Area Forecast results. Included here is a revised discussion of the evaluation measures presented in Chapter VI of Small Area Forecasts: Policies, Results and Evaluation. For the most part, the evaluation measures originally presented remain unchanged. However, the measures of the public costs of sewer extensions have been thoroughly revised, and additional measures have been included concerning road construction and maintenance. In addition, the methods used to derive the evaluation measures are described here in detail.

TABLE OF CONTENTS

	Page
Abstract-----	i
Title Page-----	iii
Preface-----	v
Table of Contents-----	vii
List of Figures-----	ix
List of Tables-----	x
 Chapter I: Introduction-----	 1
 Chapter II: Development Costs-----	 5
School Costs-----	7
Derivation of School Costs-----	9
The Public Costs of Sewer and Water Lines-----	10
Derivation of the Public Costs of Sewer and Water Lines-----	14
Private Capital Costs-----	17
Derivation of Private Capital Costs-----	22
Footnotes-----	24
 Chapter III: Environmental Impacts-----	 25
Conversion of Environmentally Sensitive Land-----	27
Residential Energy Consumption-----	31
Air Pollution Loadings from Residential Sources-----	33
Derivation of Residential Energy Consumption and Pollutant Loadings-----	33

Mobile Source Energy Consumption-----	40
Pollutant Loadings Generated From Mobile Source Energy Consumption-----	42
Water Quality: The SEM-STORM Results-----	45
The SEM-STORM Water Quality Model-----	52
Footnotes-----	52
Chapter IV: Transportation-----	55
TRIMS Model Run: Results-----	57
The TRIMS Model Run Background-----	59
Transportation System Costs-----	63
Derivation of Transportation System Costs-----	69
Footnotes-----	69
Appendix A: Development of Community Groups-----	71

LIST OF FIGURES

	Page
Figure 1 Total Private Capital Costs by Community Group and Alternative-----	20
Figure 2 Total Private Capital Costs by County and Alter- native-----	21
Figure 3 Calculation of Proportion of Dwelling Units by Type-----	33
Figure 4 Basins Used for Water Quality Analysis-----	51
Figure A-1 Community Groupings for SAF Evaluation-----	76

LIST OF TABLES

	Page
Table 1 Change in Classrooms from 1970 to Year 2000 and Associated Capital Costs by County-----	8
Table 2 Vacant Acres Proposed to be Sewered Between 1975 and 2000 by County-----	11
Table 3 Vacant Acres Proposed to be Sewered Between 1975 and 2000 by Community Groups-----	11
Table 4 Estimated Sewer System Collector Costs by County-----	12
Table 5 Estimated Sewer System Collector Costs by Community Group-----	12
Table 6 Estimated Water Transmission Main Costs by County-----	13
Table 7 Estimated Water Transmission Main Costs by County Group-----	13
Table 8 Cost Estimates for Extending Sewer Interceptors-----	15
Table 9 Cost Estimates for Extending Major Water Transmission Mains-----	16
Table 10 Private Capital Costs by County-----	18
Table 11 Private Capital Costs by Community Group-----	19
Table 12 Private Capital Costs per Dwelling Unit by Density Class-----	23
Table 13 1970 Sensitive Land Converted by 2000 by County-----	29
Table 14 1970 Sensitive Land Converted by 2000 by Community Group-----	30
Table 15 Year 2000 Residential Energy Usage by Dwelling Unit Type-----	32
Table 16 Year 2000 Total Suspended Particulate Emissions from Residential Sources-----	34

Table 17	Year 2000 Carbon Monoxide Emissions from Residential Sources-----	35
Table 18	Year 2000 Sulfur Oxide Emissions from Residential Sources-----	36
Table 19	Year 2000 Nitrogen Oxide Emissions from Residential Sources-----	37
Table 20	Year 2000 Hydrocarbon Emissions from Residential Sources-----	38
Table 21	Average Yearly Residential Energy Usage per Dwelling Unit by Fuel Type-----	39
Table 22	Pollutants in Pounds per BTU Consumed-----	40
Table 23	Year 2000 Regionwide Mobile Source Energy Consumption per Average Weekday-----	41
Table 24	Year 2000 Regionwide Mobile Source Emissions per Average Weekday-----	43
Table 25	Pollutant Emission Factors by Vehicle Type-----	44
Table 26	Speed Adjustment Factors-----	44
Table 27	Year 2000 Non-Point Suspended Solids by Basin-----	46
Table 28	Year 2000 Urban Non-Point Suspended Solids Loadings by Basin-----	48
Table 29	Year 2000 Total Vehicle Miles of Travel-----	58
Table 30	Year 2000 Average Work Trip Length in Minutes by Mode-----	58
Table 31	Year 2000 Percent of Jobs within 45 Minutes by Network Type-----	58
Table 32	Year 2000 Home-Based Work Trip Mode Splits-----	60
Table 33	Year 2000 Mode Split for Detroit CBD Home Based Work Trips-----	61
Table 34	Year 2000 Total Vehicle Trip Table-----	62
Table 35	Freeway Additions-----	64
Table 36	Total Highway Capital Costs-----	65
Table 37	Estimated Maintenance Costs, New Construction-----	67

Table 38	Total Cost of Transportation Improvements by Alternative-----	68
Table A-1	Community Group Classification-----	74
Table A-2	Community Groups by County-----	74
Table A-3	List of Minor Civil Divisions by Community Group-----	77

CHAPTER I: INTRODUCTION

CHAPTER I: INTRODUCTION

The results of the Small Area Forecast show how households, population and employment are likely to be distributed in the year 2000 if local governments adopt different public policies regionwide. By themselves, these results show how regional development may be influenced by public policy. In determining whether one set of policies is preferable to another, it is useful to show how the patterns of regional development that result from different policy alternatives are likely to affect general public concerns such as the level of public expenditures, environmental quality and energy consumption.

As an aid to the evaluation of six Small Area Forecast alternatives, three sets of evaluation measures were developed and are presented in the following chapters. Chapter II deals with the public and private costs associated with providing physical facilities to serve new development. Chapter III presents measures that indicate how each policy alternative affects environmental quality and natural resources in the region. Finally, Chapter IV provides information concerning how regional transportation systems would be affected under each alternative.

Discussion of each evaluation measure is presented in two sections. The first section describes the measure and discusses how it varies under each policy alternative. The second section describes how the measure was derived.

Each of the evaluation measures presented in this report are intended to be used only to compare the relative merits of the Small Area Forecast policy alternatives. While each measure was carefully developed to reflect the relative impact of different patterns of development, the absolute values of the measures of costs, or pollution levels, for example, are not intended to be projections of actual conditions in the year 2000. Rather, they are meant to suggest that Alternative A may be twice as costly or may generate half the pollutants as Alternative B.

The evaluation results presented in each of the following chapters are provided for the region as a whole, individual counties and the City of Detroit and by a community group classification. The community group typology was developed to dramatize shifts in the urban structure of the region that occur as a result of the policy alternatives. Seven groups were established based on measures of degree of urbanization, and type of political jurisdiction. The development of these community groups, their definition and a list of the communities that make up each group appear in Appendix A of this report.

CHAPTER II: DEVELOPMENT COSTS

SCHOOL COSTS

Capital investment in school buildings and classroom facilities accounts for a substantial amount of the total debt carried by school districts in Southeast Michigan. As the region's population of school aged children increases, new facilities must be constructed. In addition, decline in the school aged population means that existing facilities may not be needed in some school districts.

In order to determine the effects of changes in the population of school aged children on the demand for school facilities, the need for classrooms was estimated for in the year 2000 and compared with the number required in 1970. Based on the change in classroom requirements from 1970 to 2000, the cost of new classroom construction, and the replacement value of unneeded classrooms were calculated. The results of these calculations appear in Table 1.

Regionwide, the single factor having the greatest impact on the demand for classrooms is the decline in school enrollment. From 1970 to 2000, the population of school aged children is forecast to decline from 1,364,342 to 1,172,822, a loss of 191,520 children. This translates into a need for 6,950 fewer classrooms in 2000 than were in use in 1970. In addition, the distribution of population within the region will influence school enrollment. As population tends to shift away from the existing urbanized areas into newly developing areas, even more classrooms will be left unused, while new classroom construction will increase in the suburbs.

Because the policy alternatives vary in the extent they shift population out of the existing urbanized area, the need for new construction varies also. School enrollment in the existing urban areas remains highest under Alternatives 3 and 6. However, in both cases, slightly over 9000 new classrooms would be required in the region as a whole. Alternatives 1 and 2 require slightly more new facilities, and Alternatives 4 and 5, which actively encourage development outside the existing urbanized area require substantially greater new investment. The dollar cost of the new construction ranges from a low of \$1.36 billion under Alternative 3, to a high of \$2.60 billion under Alternative 4. Since an existing classroom is abandoned for every new classroom built, where construction requirements are least, enrollment is highest in the existing urbanized areas.

At the county level, similar patterns emerge. Table 1 shows the number of new and unused classrooms in each county and indicates the cost of new construction, and the replacement value of the abandoned classrooms. In

TABLE 1
CHANGE IN CLASSROOMS FROM 1970 TO YEAR 2000,
AND ASSOCIATED CAPITAL COSTS BY COUNTY

County	Classrooms	Alternative					
		1	2	3	4	5	6
Detroit	Unused	6186	6377	5637	9284	7375	5737
	New	0	0	0	0	0	0
	Value Unused ¹	936.64	965.06	854.76	1399.80	1115.01	869.44
	Cost New	0	0	0	0	0	0
Out-Wayne	Unused	4474	4834	4529	6680	5004	4628
	New	1657	1996	1565	1010	1242	1444
	Value Unused	667.73	721.37	676.08	997.00	747.18	690.88
	Cost New	249.86	300.37	235.90	151.67	187.44	217.67
Oakland	Unused	2853	2329	2092	3969	3025	2720
	New	1643	2436	1391	2325	2498	1645
	Value Unused	427.15	348.96	448.05	593.70	452.70	407.15
	Cost New	247.87	366.91	209.56	350.25	376.03	247.83
Macomb	Unused	2472	2412	2408	3503	2645	2479
	New	1311	1254	1411	1240	1056	1105
	Value Unused	362.66	355.32	353.81	514.87	388.18	363.84
	Cost New	199.64	191.98	215.34	169.18	161.31	169.19
Washtenaw	Unused	293	273	210	523	253	229
	New	1576	1217	1855	3147	1912	1706
	Value Unused	51.07	46.94	35.92	86.69	14.04	39.72
	Cost New	232.77	177.93	272.08	468.91	261.97	250.39
Monroe	Unused	71	73	67	89	72	75
	New	1483	1050	1251	2032	1253	837
	Value Unused	10.74	10.91	10.05	10.73	10.72	11.26
	Cost New	222.75	157.80	188.08	304.60	188.28	126.44
St. Clair	Unused	173	195	165	285	164	166
	New	987	1119	821	5758	1232	896
	Value Unused	26.23	29.45	24.95	42.99	24.81	25.13
	Cost New	147.71	167.81	123.11	361.86	164.56	134.55
Livingston	Unused	0	0	0	0	0	0
	New	920	469	774	1384	2404	1464
	Value Unused	0	0	0	0	0	0
	Cost New	138.41	69.67	115.99	281.41	359.30	218.52
REGION	Unused	16522	16493	16008	24333	18538	16034
	New	9585	9541	9068	17396	11597	9099
	Value Unused	2482.22	2478.01	2403.62	3648.14	2782.65	2407.42
	Cost New	1439.01	1432.47	1360.06	2604.99	1738.91	1364.58

¹ = In Millions of Dollars

14

(For Comparison Purposes Only)

general, high construction costs are associated with population growth. The more rural counties, Washtenaw, Monroe, St. Clair and Livingston, will require considerable new construction under all alternatives and will have few classrooms unused by 2000. Detroit, and the more urbanized counties, are expected to experience a considerable decline in enrollment. Yet, because of population shifts within the urban counties, Detroit-Wayne, Oakland, and Macomb Counties will also require construction of new classrooms.

DERIVATION OF SCHOOL COSTS

The school costs estimated in the report were limited to the cost of building new classrooms to accommodate increases in school enrollment, and the replacement cost of existing schoolrooms that are no longer needed due to declines in school enrollment. These cost estimates were based on the change in the number of elementary and secondary school children in Minor Civil Divisions (MCDs) from 1970 to 2000. MCDs were used rather than school districts because it was not possible to aggregate the forecast data to the school district level. Where MCDs gained children, the cost of new classroom construction was calculated; where MCDs lost children, replacement cost of unused classrooms was calculated.

For the purposes of this analysis, elementary school grades were limited to kindergarten through six, while seven through twelve were considered secondary school grades. Elementary school enrollment was approximated by the number of children aged five to eleven years, and secondary school enrollment was approximated by the number of children aged twelve to eighteen years.

For each alternative, the number of elementary and secondary school children was calculated for each MCD in 1970, and the year 2000. The change of school children in each category was calculated by subtracting the total in 1970 from the total in 2000. Where this change was positive, an MCD experienced an increase in school enrollment. Negative change indicated decline in enrollment.

MCDs were separated into two groups based on whether they gained or lost enrollment. Where enrollment increased the cost of new needed classrooms, the increase was calculated. Where enrollment declined, the replacement value of the classrooms left unused was calculated. In either case, the same procedure was used to estimate the costs involved. Separate costs were developed for elementary and secondary school children.

Change in elementary classrooms was computed by dividing the change in school children by 26.76 children per elementary classroom. This figure was then multiplied by \$113,944, the average cost of building a new classroom. The change in secondary school children was divided by 28.14 children per classroom to estimate the change in secondary classrooms. The change in classrooms was multiplied by \$180,096, the average cost of building a new secondary classroom, to estimate the dollar value of the change in classrooms. The classroom cost and size factors were based on data collected in 1976 by the Michigan Department of Education.¹ The

total cost of new classroom construction was derived by summing the costs calculated for MCDs that gained school enrollment, while the replacement cost of classrooms left unused was calculated by summing the cost calculated for MCDs that lost enrollment.

Where MCDs gained school children, the classroom cost represented the cost of constructing new classrooms; where MCDs lost school children, the cost represented the replacement value of classrooms left unused. Because of the nature of these estimates, an MCD could not have both kinds of costs. Each type of cost was aggregated separately for elementary and secondary schools and summed to the county level.

THE PUBLIC COSTS OF SEWER AND WATER LINES

A key policy element of each of the six forecast alternatives is the extension of sewer lines to areas that currently have no sewer service. The availability of sewers enables higher density residential development, and increases the capacity of an area to accommodate new growth. At the same time, the extension of new sewer lines represents a substantial capital investment, a factor which must be considered as the alternatives are evaluated.

Tables 2 and 3 show the number of acres of vacant land that are scheduled to be sewered over the forecast period. These figures form the basis of cost analysis that follows. At one extreme, close to two million additional acres of vacant and agricultural land will receive sewer service beyond the 176,000 acres of vacant sewered land available in the region in 1970. At the other extreme, Alternative 2 proposes that new sewer lines be installed to serve only 86,000 additional acres. The other alternatives fall between these extremes, ranging from a low of close to 202,000 acres under Alternative 6 to 366,000 acres under Alternative 5.

A major portion of the sewer and water line costs associated with each alternative are presented in Tables 4 through 7. These are the costs of installing sewer collector lines which link sewer lines in developments with sewer interceptors, and water transmission mains which distribute water to developments. The costs of sewer interceptors and major water transmission mains are not included in these tables.

Tables 4 through 7 show similar patterns for regional sewer and water costs. Total regional costs for sewer collector lines range from \$97.6 million to \$2.7 billion reflecting the vast difference in the amount of land sewered under Alternatives 2 and 4. The costs of water transmission mains range from \$58.6 million to \$1.6 billion.

Alternative 2 emerges as the least cost alternative for nearly all counties and community groups. St. Clair County and the older communities in groups 1 and 3 show least costs under Alternative 6. Alternative 4 is the most costly in all cases except for Groups 1 and 3 show least costs under Alternative 6. Alternative 4 is the most costly in all cases except for Group 2 communities where Alternative 1 produces the highest

TABLE 2

VACANT ACRES PROPOSED TO BE SEWERED BETWEEN 1975 AND 2000 BY COUNTY

County	Alternative					
	1	2	3	4	5	6
Detroit	0	0	0	0	0	0
Out Wayne	40,818	13,819	39,940	75,711	40,084	30,382
Oakland	70,286	23,981	57,805	344,810	125,393	61,027
Macomb	51,588	16,795	54,171	181,619	54,250	39,443
Washtenaw	30,122	3,517	34,699	356,588	36,460	27,673
Monroe	53,977	12,843	25,419	312,807	38,903	22,825
St. Clair	19,617	12,752	30,989	389,193	34,204	11,504
Livingston	10,390	2,723	8,868	310,285	36,710	8,883
REGION	276,798	86,430	251,891	1,971,013	366,004	201,737

TABLE 3

VACANT ACRES PROPOSED TO BE SEWERED BETWEEN 1975 AND 2000
BY COMMUNITY GROUP

Community Group	Alternative					
	1	2	3	4	5	6
1	771	764	764	1,556	764	764
2	35,454	14,633	33,289	39,809	37,525	33,870
3	366	16	366	387	366	59
4	18,565	7,475	16,978	38,430	20,860	14,111
5	92,423	28,410	75,180	206,242	123,187	73,896
6	35,486	11,470	20,804	1,210,673	57,660	11,671
7	93,733	23,662	104,510	473,916	125,642	67,366
REGION	276,798	86,430	251,891	1,971,013	366,004	201,737

TABLE 4

ESTIMATED SEWER SYSTEM COLLECTOR COSTS BY COUNTY

(Costs in Millions of Dollars)

County	Alternative					
	1	2	3	4	5	6
Detroit	0.0	0.0	0.0	\$ 0.0	0.0	0.0
Out Wayne	\$102.0	\$ 34.5	\$ 99.9	\$ 189.3	\$100.2	\$ 76.0
Oakland	\$175.7	\$ 60.0	\$144.5	\$ 862.0	\$313.5	\$152.6
Macomb	\$129.0	\$ 42.0	\$135.4	\$ 454.0	\$135.6	\$ 98.6
Washtenaw	\$ 75.3	\$ 8.8	\$ 86.7	\$ 891.5	\$ 91.2	\$ 69.2
Monroe	\$134.9	\$ 32.1	\$ 63.5	\$ 782.0	\$ 97.3	\$ 57.1
St. Clair	\$ 49.0	\$ 31.9	\$ 77.5	\$ 973.0	\$ 85.5	\$ 28.8
Livingston	\$ 26.0	\$ 6.8	\$ 22.2	\$ 775.7	\$ 91.8	\$ 22.2
REGION*	\$692.0	\$216.1	\$629.7	\$4,927.5	\$915.0	\$504.3

*Columns may not sum to regional totals due to rounding errors.

TABLE 5

ESTIMATED SEWER SYSTEM COLLECTOR COSTS BY COMMUNITY GROUP

(Costs in Millions of Dollars)

Community Group	Alternative					
	1	2	3	4	5	6
1	\$ 1.9	\$ 1.9	\$ 1.9	\$ 3.9	\$ 1.9	\$ 1.9
2	\$ 88.6	\$ 36.6	\$ 83.2	\$ 99.5	\$ 93.8	\$ 84.7
3	\$ 0.9	\$ 0.04	\$ 0.9	\$ 1.0	\$ 0.9	\$ 0.1
4	\$ 46.4	\$ 18.7	\$ 42.4	\$ 96.1	\$ 52.2	\$ 35.3
5	\$231.1	\$ 71.0	\$188.0	\$ 515.6	\$308.0	\$184.7
6	\$ 88.7	\$ 28.7	\$ 52.0	\$3,026.7	\$144.2	\$ 29.2
7	\$234.3	\$ 59.2	\$261.3	\$1,184.8	\$314.1	\$168.4
REGION*	\$692.0	\$216.1	\$629.7	\$4,927.5	\$915.0	\$504.3

*Columns may not sum to regional totals due to rounding error.

TABLE 6

ESTIMATED WATER TRANSMISSION MAIN COSTS BY COUNTY
(Costs in Millions of Dollars)

	Alternative					
	1	2	3	4	5	6
Detroit	0.0	0.0	0.0	0.0	0.0	0.0
Out Wayne	\$ 61.2	\$ 20.7	\$ 59.9	\$ 113.6	\$ 60.1	\$ 45.6
Oakland	\$105.4	\$ 36.0	\$ 86.7	\$ 517.2	\$188.1	\$ 91.5
Macomb	\$ 77.4	\$ 25.2	\$ 81.3	\$ 272.4	\$ 81.4	\$ 59.2
Washtenaw	\$ 45.2	\$ 5.3	\$ 52.0	\$ 534.9	\$ 54.7	\$ 41.5
Monroe	\$ 81.0	\$ 19.3	\$ 38.1	\$ 469.2	\$ 58.4	\$ 34.2
St. Clair	\$ 29.4	\$ 19.1	\$ 46.5	\$ 583.8	\$ 51.3	\$ 17.3
Livingston	\$ 15.6	\$ 4.1	\$ 13.3	\$ 465.4	\$ 55.1	\$ 13.3
REGION*	\$415.2	\$129.6	\$377.8	\$2,956.5	\$549.0	\$302.6

*Columns may not sum to regional totals due to rounding error

TABLE 7

ESTIMATED WATER TRANSMISSION MAIN COSTS BY COMMUNITY GROUP
(Costs in Millions of Dollars)

Community Group	Alternative					
	1	2	3	4	5	6
1	\$ 1.2	\$ 1.1	\$ 1.1	\$ 2.3	\$ 1.1	\$ 1.1
2	\$ 53.2	\$ 21.9	\$ 49.9	\$ 59.7	\$ 56.3	\$ 50.8
3	\$ 0.5	\$ 0.02	\$ 0.5	\$ 0.6	\$ 0.5	\$ 0.1
4	\$ 27.8	\$ 11.2	\$ 25.5	\$ 57.6	\$ 31.3	\$ 21.2
5	\$138.6	\$ 42.6	\$112.8	\$ 309.4	\$184.8	\$110.8
6	\$ 53.2	\$ 17.2	\$ 31.2	\$1,816.0	\$ 86.5	\$ 17.5
7	\$140.6	\$ 35.5	\$156.8	\$ 710.9	\$188.5	\$101.0
REGION*	\$415.2	\$129.6	\$377.8	\$2,956.5	\$549.0	\$302.6

*Columns may not sum to regional totals due to rounding error.

costs. On the whole, Alternative 6 is the next least costly alternative for almost all counties and community groups. Alternative 5 schedules extensive sewerage of township areas, and moderate sewerage of the remaining areas, with the result that in most cases, it is the most costly alternative after Alternative 4.

DERIVATION OF THE PUBLIC COSTS OF SEWER AND WATER LINES

The physical layout of a municipal sanitary sewerage system may be divided into four elements: the treatment plant, and three stages of pipeline networks. At the first stage of the pipeline network are the sewer lines installed at the site of new development. These are generally financed by private developers and typically are not public costs. These lines feed into second stage collector lines, which are moderately sized pipe linking first stage networks with third stage lines. Third stage lines are interceptors consisting of large pipe which feeds directly into sewage treatment facilities or other interceptors. Water line networks follow a similar hierarchy. In estimating the public costs of sewer and water lines, only the costs of second and third stage networks and treatment facilities were considered. First stage costs for both sewer and water lines are analyzed in the following section on private costs. To simplify analysis, it was assumed that where sewer service is provided, water mains are also installed.

The costs per acre of installing second stage water and sewer lines do not vary greatly throughout the seven-county region. Given that new sewerage development is reasonably close to existing or proposed third stage networks, installation costs of the required amount of second stage pipelines are reasonably constant. For this reason, regional average costs of \$2,500 per acre for sewers, and \$1,500 per acre for water were used to estimate the costs of installing second stage networks in the region.²

The costs of installing third stage networks and treatment plants for new development in the region are complicated by engineering considerations which make it difficult to determine the minimum cost of a particular policy alternative.

The problems arise in determining whether it is more effective to serve new development through new or existing facilities. In making this decision, it is necessary to consider the capacities of existing systems and the size of the population that will eventually be sewerage. Where capacity exists to accommodate some, but not all new growth, it may be cheaper in the long run to build a separate facility to accommodate all of the new growth. This would avoid a future need of having to build new facilities to serve a small number of people. In such cases, other solutions may be more appropriate. Finally, geographic factors must be considered. Topography and urban development may make installation of interceptors prohibitively expensive by requiring circuitous routing of lines or tunneling rather than open excavation.

Tables 8 and 9 are provided to indicate interceptor costs for sewer

TABLE 8
COST ESTIMATES FOR EXTENDING SEWER INTERCEPTORS

Population Served	Required Pipe Diameter in Inches	Cost Per Mile in 1978 Dollars to Cut and Fill	Cost Per Mile in 1978 Dollars to Tunnel
0 - 1,999	12	\$ 211,200	\$ -
2,000 - 2,999	15	\$ 237,600	\$ -
3,000 - 5,999	18	\$ 264,000	\$ -
6,000 - 7,999	21	\$ 316,800	\$ -
8,000 - 11,999	24	\$ 369,600	\$ -
12,000 - 17,999	27	\$ 422,400	\$ -
18,000 - 24,999	30	\$ 475,200	\$ -
25,000 - 36,999	36	\$ 528,000	\$ 1,320,000
37,000 - 56,999	42	\$ 580,800	\$ 1,372,800
57,000 - 79,999	48	\$ 660,000	\$ 1,584,000
80,000 - 106,999	54	\$ 739,200	\$ 1,663,200
107,000 - 144,999	60	\$ 818,400	\$ 1,742,400
145,000 - 184,999	66	\$ 897,600	\$ 1,821,600
185,000 - 234,999	72	\$ 976,800	\$ 1,900,800
235,000 - 275,000	78	\$ 1,056,000	\$ 1,980,000

TABLE 9
COST ESTIMATES FOR EXTENDING MAJOR WATER TRANSMISSION MAINS

Population Served	Required Pipe Diameter in Inches	Cost Per Mile in 1789 Dollars
0 - 9,999	12	\$ 184,800
10,000 - 19,999	18	\$ 211,200
20,000 - 39,999	24	\$ 237,600
40,000 - 69,999	30	\$ 316,800
70,000 - 119,999	36	\$ 396,000
120,000 - 159,999	One 36 inch pipe plus one 24 inch pipe	\$ 633,600
160,000+	Two 36 inch pipes	\$ 792,000

systems, and water main transmission line costs.³ The tables show the costs per mile for pipelines serving different sized population. To use these tables, it is necessary to estimate the population expected to be sewered and the length of interceptor lines required. It should be noted that accurate estimates of interceptor and treatment facilities costs require detailed engineering analysis.

PRIVATE CAPITAL COSTS

The policies reflected in the six alternatives are likely to have a significant impact on the cost of housing development. Although these policies will have little effect on housing construction costs, development densities affect the costs of preparing a lot for development. Since the cost of land accounts for as much as 20 percent of the sale price of a housing unit, savings in development costs make new housing more affordable. In order to determine how lot preparation costs vary under different alternatives, estimates were derived for the costs of providing sewer lines, water mains and roads within areas of new development in the region.

Tables 10 and 11 present the private capital costs for roads, sanitary sewers, and water mains by county and community group. The total investment required under each alternative depends on the amount of new construction that occurs during the forecast period and the average cost per dwelling unit. With an average density of new development in excess of eight dwelling units per acre, Alternatives 2 and 4 produce the lowest private capital cost per unit of close to \$2,850. The alternatives differ widely in the number of new units constructed, however. Under Alternative 4, over a million are built, while fewer than 868,000 are built under Alternative 2. This means that the total private investment required under Alternative 2 is \$2.486 billion or \$353 million less than the \$2,839 billion required under Alternative 4.

The least amount of new construction occurs under Alternative 3 with an average private capital investment of \$3,940.30 per dwelling unit. Even though fewer units are constructed, the total private investment exceeds that of Alternative 2 by nearly \$800 million. This is due to the lower average density of development that occurs under Alternative 3. The remaining alternatives produce moderate amounts of new construction compared with the others. But because the average density of new development is low, the other alternatives have greater requirements for private investment, ranging as high as a total of \$3.996 billion of Alternative 5.

How the distribution of costs across community groups varies with each alternative provides additional insight into the total private cost of development. Figures 1 and 2 show the distribution of private costs by county and community group, respectively. Under Alternative 1, 60 percent of new housing construction occurs in the townships where the average private investment per unit ranges \$4,728 to \$5,104. These costs are well in excess of the cost of development occurring in the more urbanized areas under this alternative. Alternative 6 follows an almost identical pattern except that the private capital costs associated with

TABLE 10

PRIVATE CAPITAL COSTS BY COUNTY

(In Millions of Dollars)

(For Comparison Purposes Only)

County	Measure	Alternative					
		1	2	3	4	5	6
Detroit	Sewers	20.37	25.87	28.86	8.92	17.27	28.53
	Water Mains	12.04	15.23	17.06	5.37	10.15	16.86
	Roads	54.21	68.64	76.89	24.09	45.71	75.96
	Total	86.62	109.74	122.81	38.38	73.13	121.35
Out-Wayne	Sewers	192.36	125.07	179.35	80.30	162.67	178.79
	Water Mains	118.67	76.32	110.21	49.08	99.95	110.32
	Roads	340.23	314.69	309.06	195.33	272.22	306.52
	Total	651.26	516.08	598.62	324.71	534.84	595.63
Oakland	Sewers	161.44	117.35	115.40	122.40	188.01	164.23
	Water Mains	106.69	73.35	75.62	75.61	123.46	109.14
	Roads	718.37	609.92	603.35	478.11	884.50	770.50
	Total	986.50	800.62	794.37	676.12	1195.97	1043.87
Macomb	Sewers	151.21	81.98	148.90	74.17	134.98	142.88
	Water Mains	95.94	49.94	93.90	45.15	85.20	91.12
	Roads	330.34	259.19	320.63	208.81	297.11	323.52
	Total	577.49	391.11	563.43	328.13	517.29	557.52
Washtenaw	Sewers	84.20	46.67	67.02	86.80	90.81	98.40
	Water Mains	54.24	28.51	40.96	53.14	57.58	63.34
	Roads	305.47	143.53	219.22	249.29	344.97	337.66
	Total	443.91	218.71	327.20	389.23	493.36	499.40
Monroe	Sewers	97.34	34.70	77.08	59.74	77.23	72.50
	Water Mains	66.58	21.21	50.22	36.53	50.06	47.70
	Roads	362.83	121.61	273.82	185.43	284.99	261.71
	Total	526.75	177.52	401.12	281.70	412.28	381.91
St. Clair	Sewers	57.24	34.35	61.61	133.08	66.41	49.39
	Water Mains	37.66	20.92	40.27	81.20	42.91	31.53
	Roads	191.48	134.24	162.16	372.43	223.44	181.90
	Total	286.38	189.51	264.04	586.71	332.76	262.82
Livingston	Sewers	13.17	6.43	18.32	41.40	33.69	21.22
	Water Mains	8.69	3.92	12.02	25.26	22.66	14.31
	Roads	151.43	72.29	181.77	147.56	379.79	298.40
	Total	173.29	82.64	212.11	214.22	436.14	333.93
REGION	Sewers	777.23	472.42	696.54	606.81	771.07	755.94
	Water Mains	500.51	289.40	440.26	371.34	491.97	484.32
	Roads	2454.36	1724.11	2146.90	1861.05	2732.73	2556.17
	Total	3732.20	2485.93	3283.70	2839.20	3995.77	3796.43

TABLE 11

PRIVATE CAPITAL COSTS
BY COMMUNITY GROUP
(In Millions of Dollars)

(For Comparison Purposes Only)

Community Group	Measure	Alternative					
		1	2	3	4	5	6
Group 1	Sewers	52.02	50.79	57.12	21.31	42.01	56.34
	Water Mains	31.35	30.46	34.21	12.96	25.15	33.71
	Roads	122.62	141.70	140.59	62.65	101.75	139.53
	Total	205.99	222.95	231.92	96.92	168.91	229.58
Group 2	Sewers	177.78	121.17	156.23	79.09	161.19	173.91
	Water Mains	113.29	75.15	98.56	48.79	102.32	110.85
	Roads	394.44	328.45	342.08	219.18	359.77	385.77
	Total	685.51	524.77	596.87	347.06	623.28	670.53
Group 3	Sewers	3.22	2.54	3.40	1.77	3.73	3.18
	Water Mains	2.00	1.54	2.10	1.08	2.33	1.97
	Roads	7.58	7.36	7.81	5.68	8.92	7.35
	Total	12.80	11.44	13.31	8.53	14.98	12.50
Group 4	Sewers	73.18	52.46	64.13	42.01	67.97	61.72
	Water Mains	46.28	32.02	40.23	25.62	42.57	39.07
	Roads	206.13	162.99	176.50	121.56	189.17	175.92
	Total	325.59	247.47	280.86	189.19	299.71	276.71
Group 5	Sewers	244.36	144.83	205.24	122.81	245.79	245.91
	Water Mains	153.12	88.82	130.56	75.42	158.20	159.26
	Roads	702.49	530.33	571.56	408.01	716.60	709.15
	Total	1104.97	763.98	907.36	606.24	1120.59	1114.32
Group 6	Sewers	60.36	22.06	39.12	228.40	65.16	31.99
	Water Mains	42.08	13.46	25.95	139.36	43.22	21.51
	Roads	516.43	263.83	408.62	700.14	757.86	548.65
	Total	618.87	299.35	473.69	1067.90	866.24	602.15
Group 7	Sewers	166.42	78.58	171.29	111.43	185.22	182.87
	Water Mains	107.38	47.96	108.67	68.12	118.16	117.96
	Roads	504.67	289.45	499.75	343.82	598.66	589.81
	Total	778.47	415.99	779.71	523.37	902.04	890.64
REGION	Sewers	777.34	472.43	696.53	606.82	771.07	755.92
	Water Mains	500.50	289.41	440.28	371.35	491.95	484.33
	Roads	2454.36	1724.11	2146.91	1861.04	2732.73	2556.18
	Total	3732.20	2485.95	3283.72	2839.21	3995.75	3796.43

FIGURE 1
TOTAL PRIVATE CAPITAL COSTS BY COMMUNITY GROUP AND ALTERNATIVE

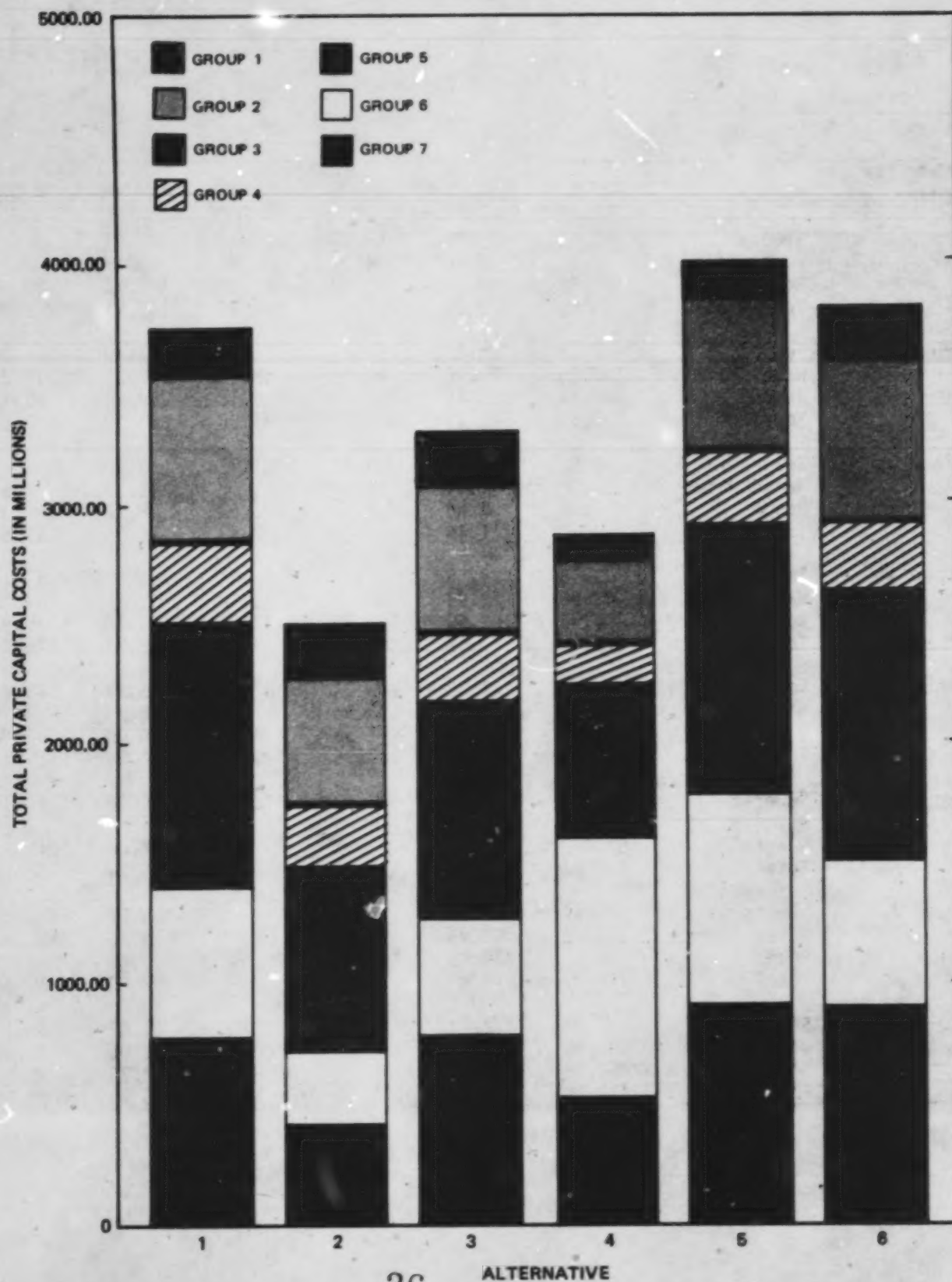
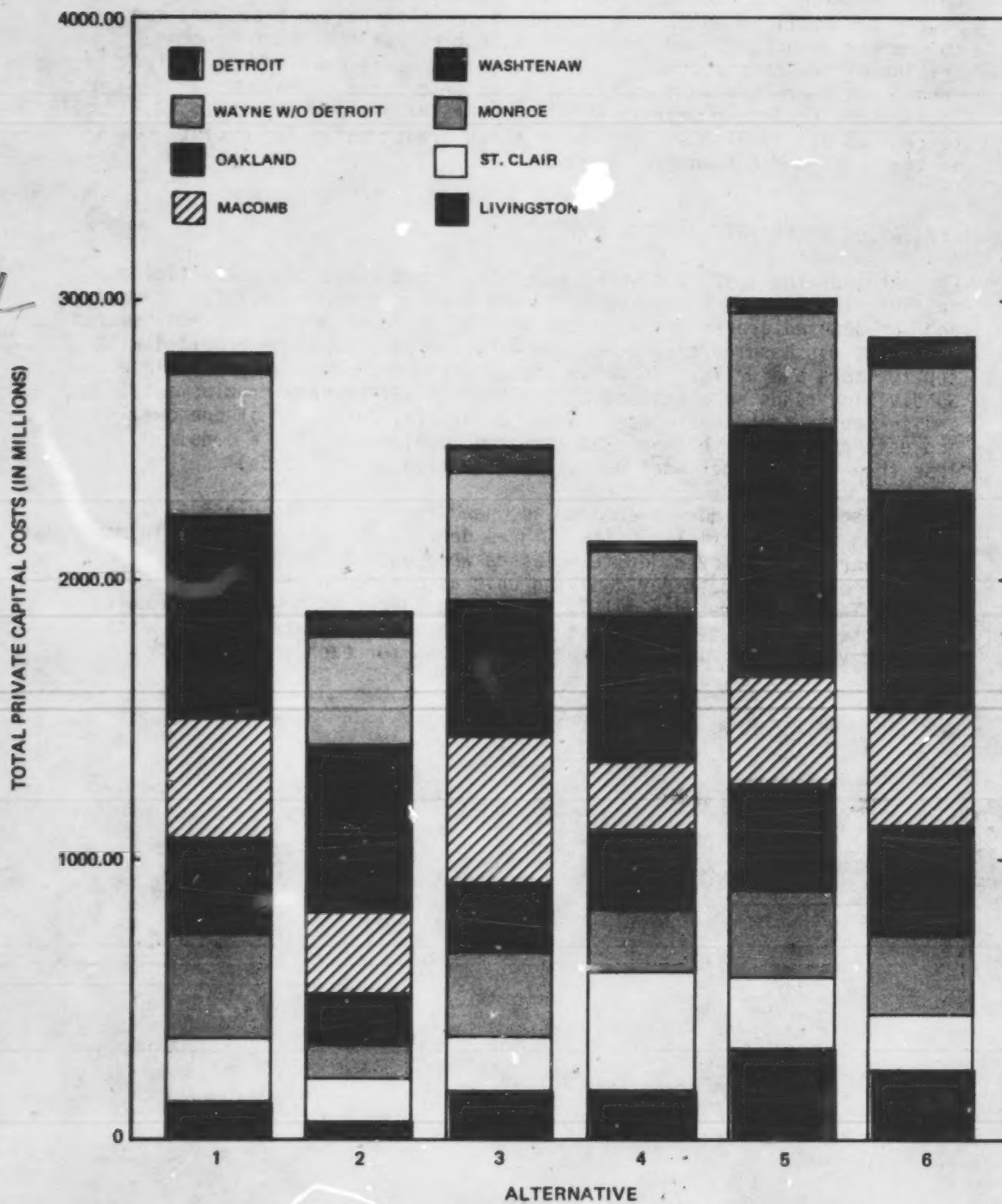


FIGURE 2
TOTAL PRIVATE CAPITAL COSTS BY COUNTY AND ALTERNATIVE



development in the townships are even higher, ranging from \$4,979 to \$5,244 per dwelling unit. The high costs of Alternative 5 are not due to greater amounts of new construction, but rather to a high concentration of new construction in the townships, where development is less dense, and therefore more costly on a per unit basis. While private development costs per unit in these areas range between \$4,526 to \$4,989, 67 percent of all development occurs in these areas, while 42 percent occurs in the least dense townships alone.

DERIVATION OF PRIVATE CAPITAL COSTS

Estimates of the cost of sewers, water lines and roads typically included in the sale price of a housing unit were developed separately for sewered and non-sewered areas, based on the density of development. In non-sewered areas, it was assumed that sewer and water service would be provided with septic tanks and wells. In these areas, only road costs were calculated. Subdivision roads were assumed to be paved in all sewered developments, and in septic tank developments with residential densities of one dwelling unit per acre or higher. Non-sewered development with a density less than one unit per acre was assumed to have gravel roads.

In both sewered and non-sewered areas, new development was classified according to residential density. Three density classes were used in non-sewered areas, and seven density classes were used in sewered areas. Table 12 shows the cost per dwelling unit associated with each density class. These factors were multiplied by the number of new dwelling units constructed in each density class to calculate the private capital costs of new development. These figures were summed for each county and MCD type.

TABLE 12

PRIVATE CAPITAL COSTS PER DWELLING UNIT BY DENSITY CLASS

(Figures are in Dollars)

	Density Class	Sewer Lines	Water Mains	Roads
<u>NON-SEWERED</u>	0. - .1375	\$ 0	\$ 0	\$1840
	.1375 - .96	0	0	\$4170
	.96 - 1.0	0	0	\$6510
<u>SEWERED</u>	1.0 - 2.0	\$2410	\$1740	\$5570
	2.0 - 2.4	\$2030	\$1360	\$4910
	2.4 - 3.4	\$1940	\$1240	\$4450
	3.4 - 4.3	\$1410	\$ 860	\$3870
	4.3 - 6.0	\$1090	\$ 650	\$2965
	6 - 20	\$ 590	\$ 360	\$ 616
	20+	\$ 150	\$ 80	\$ 370

Source: This report was taken from a report prepared for the Thompson-Brown Company entitled "Current Homesite Development Costs, An Estimate (in Detroit Metropolitan Area)," released April 1, 1976.

FOOTNOTES: CHAPTER II

¹The source of the cost and pupils per classroom data was a Michigan Department of Education report entitled, "Michigan's School Enrollment Decline: Projections and Implications."

²These figures were derived through an analysis of costs cited in grant applications reviewed by the Council.

³Ibid.

CHAPTER III: ENVIRONMENTAL IMPACTS

CHAPTER III: ENVIRONMENTAL IMPACTS

CONVERSION OF ENVIRONMENTALLY SENSITIVE LAND

In the course of urban development, agricultural land and land that has value as a natural area may be developed for residential, commercial, and industrial purposes. The amount of such environmentally sensitive land that is developed under each alternative depends on how much new development occurs, and where it is located. In order to trace the development of environmentally sensitive land under different policy alternatives, the Technical Working Group defined nine different types of sensitive land in the vacant land inventory used for each alternative. These types are:

Floodplains,

Shores,

Wetlands,

Areas with slopes greater than 12 percent,

Woods,

Other natural land forms,

Active, high potential agricultural land,

Active, low potential agricultural land,

Inactive, high potential agricultural land.

For the purposes of this evaluation, these land types were grouped into three classes: water related lands, agricultural lands and other sensitive lands. Water related lands include floodplains, shores and wetlands; agricultural lands include the three agricultural land types; and the remaining land types are classed as other sensitive land.

As the forecasts move from 1970 to 2000, vacant land of all types is converted to developed land uses, and is subtracted from the vacant land inventory. By subtracting the amount remaining after each five year model iteration, it is possible to determine the amount of each sensitive land type that was developed. The total amount converted to a developed use is then the sum of the differences between each five year period.

Three of the six alternatives, numbers 1, 2 and 6, incorporate policies regionwide that protect environmentally sensitive land from development. This is accomplished by removing fixed proportions of land coded in each sensitive land type from the vacant land inventory. Protection of this nature applies only to land that is not to be sewered during the forecast period. Since some sensitive land is sewered under each alternative, including sensitive land that was already sewered prior to 1970, some development of sensitive land types occurs under all alternatives. In addition, Alternatives 3 and 5, which have no formal preservation policies, protect land by allowing development to occur in sensitive areas only at very low densities.

The conversion of the three classes of vacant, sensitive land types to developed land uses is presented in Table 13 by county and in Table 14 by community group.

Regionwide, the least amount of sensitive land is developed under Alternative 2, and the most is developed under Alternative 5. Without any policy protecting sensitive land, Alternative 4 develops less than Alternatives 1, 3 and 6. This reflects the fact that the high density development occurring under Alternative 4 requires less land overall than the other alternatives, and consequently develops less sensitive land. The high density development occurring under Alternative 2 would have a similar effect without any protection policies. However, an additional 45,000 acres of sensitive land were protected from development. Further, Alternative 2, and the other alternatives with protection policies, converted much less water-related land than Alternative 4.

At the county level most of the undeveloped sensitive land in 1970 was located in Washtenaw, Monroe, St. Clair, and Livingston Counties. Each of these counties had more than 300,000 acres of sensitive land while the other counties had a total of 500,000 acres. In absolute terms, the most sensitive land was converted in Oakland County under nearly all alternatives, while Macomb County generally converted the least amount.

Wayne County had the least amount of sensitive land of all counties in 1970. Yet, a sizeable proportion of new development occurs in this county under all alternatives. In percentage terms, Wayne County shows the highest rate of sensitive land conversion in the region, but in absolute terms, the number of acres converted is comparatively low.

Since the policies for Wayne and Macomb Counties are essentially the same under Alternatives 3 and 5, it is interesting to note that the conversion of sensitive land differs under each alternative. This is again a reflection of the household distribution resulting from the two alternatives. More development occurs in these counties under Alternative 3. Since no protection policies apply in either county under Alternatives 3 and 5, the greater growth that occurs in Wayne and Macomb Counties under Alternative 3 results in greater development of environmentally sensitive land.

TABLE 13
1970 SENSITIVE LAND CONVERTED BY 2000
BY COUNTY (In Acres)

County	Land Type	1970* Base	Alternative					
			1	2	3	4	5	6
Detroit	Water-Related	0	0	0	0	0	0	0
	Other Sensitive	0	0	0	0	0	0	0
	Agriculture	0	0	0	0	0	0	0
	Total	0	0	0	0	0	0	0
Out-Wayne	Water-Related	4833	408	443	1203	668	1077	492
	Other Sensitive	24238	6922	5112	6946	3643	6157	6542
	Agriculture	101108	27868	20586	27313	14849	24587	27387
	Total	130179	35198	26141	35462	19160	31821	34421
Oakland	Water-Related	41013	2350	2518	1563	5759	15595	2050
	Other Sensitive	59601	21548	14567	26603	11493	26405	20810
	Agriculture	134218	37246	12244	10706	17694	56630	35452
	Total	234832	61144	29329	38872	34946	98630	58312
Macomb	Water-Related	10771	267	300	1508	1003	1429	399
	Other Sensitive	13644	1958	1034	2339	1212	2169	2061
	Agriculture	118439	13619	7183	15508	9308	14866	14665
	Total	142854	15844	8517	19355	11523	18464	17125
Washtenaw	Water-Related	15222	255	150	822	794	1401	299
	Other Sensitive	56699	5235	1563	4375	3375	6562	5379
	Agriculture	307588	37846	15283	31376	21959	49169	40486
	Total	379509	43336	16996	36573	26128	57132	46164
Monroe	Water-Related	40652	834	850	284	3367	8421	869
	Other Sensitive	25949	5998	1815	6609	1665	6312	5360
	Agriculture	250596	53515	13120	57865	16475	57012	44794
	Total	317197	60347	15785	64758	21507	71745	51023
St. Clair	Water-Related	22787	744	566	957	2578	2521	786
	Other Sensitive	44532	5260	2208	4051	4165	6467	4009
	Agriculture	291277	29393	6205	17168	24797	36656	25066
	Total	358596	35397	8979	22176	31540	45644	29861
Livingston	Water-Related	41342	336	294	64	1595	5377	280
	Other Sensitive	83733	10978	3189	2635	4494	26188	13080
	Agriculture	179838	23454	6202	28080	9557	59415	33102
	Total	304913	34768	9685	30779	15646	90980	46462
REGION	Water-Related	176620	5194	5121	6401	15764	35821	5175
	Other Sensitive	308396	57899	29488	53558	30047	80260	57241
	Agriculture	1383064	222941	80823	188016	114639	298335	220952
	Total	1868080	286034	115432	247975	160450	414416	283368

*1970 base from Alternative 5

TABLE 14
1970 SENSITIVE LAND CONVERTED BY 2000
BY COMMUNITY GROUP (In Acres)

Community Group	Land Type	1970* Base	Alternative					
			1	2	3	4	5	6
Group 1	Water-Related	307	31	30	213	136	201	39
	Other Sensitive	788	395	321	322	244	302	318
	Agriculture	1307	453	452	474	390	409	471
	Total	2402	879	803	1009	770	912	828
Group 2	Water-Related	4814	472	869	491	1526	2057	487
	Other Sensitive	15357	7238	6255	6547	4470	6770	7055
	Agriculture	18660	6340	4930	5690	3682	5636	6377
	Total	38831	14050	12054	12728	9678	14463	13919
Group 3	Water-Related	261	7	0	20	55	162	7
	Other Sensitive	246	209	177	187	90	180	185
	Agriculture	378	289	276	290	282	289	259
	Total	885	505	453	497	427	631	451
Group 4	Water-Related	7229	487	619	536	1499	2861	518
	Other Sensitive	8374	4114	3547	4590	2408	4568	3742
	Agriculture	26187	13438	8792	9918	6717	12705	11629
	Total	41790	18039	12958	15044	10624	20134	15889
Group 5	Water-Related	27886	2172	2039	2227	4683	10220	2089
	Other Sensitive	38682	14730	9335	14291	7310	14234	14989
	Agriculture	135998	48143	27259	34619	24920	45736	47462
	Total	202566	65045	38633	51137	36913	70190	64540
Group 6	Water-Related	96640	895	630	670	4538	14140	786
	Other Sensitive	172675	18653	4523	16030	9296	38496	17249
	Agriculture	856022	99806	17766	82218	52634	165768	94906
	Total	1125337	119354	22919	98918	66468	218404	112941
Group 7	Water-Related	39483	1130	934	2244	3327	6180	1249
	Other Sensitive	72274	12560	5330	11591	6229	15710	13703
	Agriculture	344512	54472	21348	54807	26014	67792	59848
	Total	456269	68162	27612	68642	35570	89682	74800
REGION	Water-Related	176620	5194	5121	6401	15764	35821	5175
	Other Sensitive	308396	57899	29488	53558	30047	80260	57241
	Agriculture	1383064	222941	80823	188016	114655	298335	220952
	Total	1868080	286034	115432	247975	168450	414416	283368

*1970 base from Alternative 5

In the rest of the counties, Alternative 5 produces the most conversion of sensitive land types. This is due to the low density of the development that occurs under this alternative, the lack of overall policy direction to encourage development in existing urbanized areas, and the lack of protection policies for this alternative.

Among community groups, the conversion of sensitive land follows the same basic pattern throughout all alternatives. In absolute terms, Group 3 communities develop the least amount of land, followed by Groups 1, 2 and 4. However, in percentage terms, this relationship is reversed, simply because the bulk of the environmentally sensitive land in the region is located in the townships. Among the townships, the most conversion of sensitive land occurs in Group 6 for all Alternatives 1 and 2 while the least occurs in Group 5 townships in all but Alternatives 2 and 4. Any differences at this level among alternatives are due primarily to the distribution of new construction under each alternative.

RESIDENTIAL ENERGY CONSUMPTION

Residential energy consumption accounts for a significant proportion of energy requirements in the region. Much of this energy is used by single family homes, which are more energy-consumptive per household than multi-family units. For this reason, policies which promote higher density development than others would be expected to require less energy.

In order to determine how much energy savings might result from the residential development policies of each alternative, the energy usage of four types of dwelling units was calculated. Table 15 shows the results of these calculations.

Residential energy consumption reaches a peak of 65 trillion BTUs under Alternative 4 for the year 2000. The least consumption occurs under Alternative 3. Overall, there is very little difference among the alternatives which encourage high density residential construction is to increase the number of two-family homes built in the region. Since the energy requirements of these households are assumed to be identical to single family households, the shift towards more two-family construction has no effect on residential energy consumption.

Further, Alternative 2, which incorporates a substantial redevelopment program, and Alternative 4, which encourages growth outside the existing urbanized area, do not produce as many new multi-family units as might be expected. In fact, many multi-family units in the City of Detroit are demolished under Alternative 4 as vacancy rates rise, and are replaced by a mix of high and low density development elsewhere in the region. The reduction in the number of high density multi-family homes in the City of Detroit offsets the increase in multi-family homes in the rest of the region, so that the stock of multi-family units remains roughly constant. Little change occurs in the stock of multi-family units under all alternatives, and thus, the capacity of achieve significant energy savings is limited.

TABLE 15
YEAR 2000 RESIDENTIAL ENERGY USAGE BY DWELLING UNIT TYPE
(In Trillions of BTUs)
(For Comparison Purposes Only)

		Electricity	Fuel Oil	Natural Gas	Total
Alternative 1	Mobile Home	.080	.057	.391	.528
	1-Family	7.761	4.825	36.273	48.859
	2-Family	.883	.549	4.129	5.561
	Multi-Family	.667	.305	7.487	8.459
	Total	9.391	5.736	48.280	63.407
Alternative 2	Mobile Home	.076	.053	.368	.497
	1-Family	7.588	4.718	35.467	47.773
	2-Family	.987	.614	4.613	6.214
	Multi-Family	.716	.327	8.037	9.080
	Total	9.367	5.712	48.485	63.564
Alternative 3	Mobile Home	.078	.055	.379	.512
	1-Family	7.645	4.753	35.731	48.129
	2-Family	.923	.574	4.316	5.813
	Multi-Family	.684	.313	7.685	8.682
	Total	9.330	5.695	48.111	63.136
Alternative 4	Mobile Home	.082	.058	.398	.538
	1-Family	7.909	4.917	36.964	49.790
	2-Family	.908	.564	4.243	5.715
	Multi-Family	.684	.313	7.674	8.671
	Total	9.583	5.852	49.279	64.714
Alternative 5	Mobile Home	.084	.059	.411	.554
	1-Family	7.954	4.945	37.177	50.076
	2-Family	.818	.508	3.822	5.148
	Multi-Family	.638	.292	7.166	8.096
	Total	9.494	5.804	48.576	63.874
Alternative 6	Mobile Home	.079	.056	.386	.521
	1-Family	7.710	4.794	36.038	48.542
	2-Family	.899	.559	4.200	5.658
	Multi-Family	.673	.308	7.561	8.542
	Total	9.361	5.717	48.185	63.263

AIR POLLUTION LOADINGS FROM RESIDENTIAL SOURCES

The consumption of energy by households in the region generates pollutant loadings which affect air quality in the region. The major pollutants include particulates, sulphur oxides, carbon monoxides, hydrocarbons and oxides of nitrogen. Estimates of the levels of these pollutants generated by residential energy consumption were derived for each of the six alternatives. The results are presented in Tables 16 through 20.

Because the level and composition of energy consumed varies so little under each of the alternatives, there is little difference in the total level of pollutants generated. The yearly emissions of particulates ranges from 148.83 million pounds under Alternative 3 to 152.85 million pounds under Alternative 4. Carbon monoxide levels average close to 27 million pounds a year in 2000; sulphur oxides range from 750 to 770 million pounds a year; nitrogen oxides range from 591 to 607 million pounds; and hydrocarbon emissions average about 8.4 million pounds.

Land use policies controlling the density of residential development have little effect on the level of residential energy consumption or pollutant loadings. They fail by themselves to encourage substantial multi-family housing construction where the greatest energy savings, and subsequent pollution abatement could be achieved. Their principal effect is to encourage duplex type development which offers little or no advantage over single family construction in terms of energy savings. Unless housing technology shifts substantially over the next two decades, residential land use regulation, by itself, is not likely to be effective in reducing household energy consumption.

DERIVATION OF RESIDENTIAL ENERGY CONSUMPTION AND POLLUTANT LOADINGS

Analysis of residential energy consumption was based on the distribution of households by type of dwelling unit in the year 2000. The dwelling units in each MCD were identified as mobile homes, single family, two-family or multi-family residences according to a system of regression equations developed by Decision Sciences Corporation,¹ which appear in Figure 3. These equations derive the proportion of total dwelling units in each type based on the average residential density was defined as dwelling units divided by the total developed residential acreage in an MCD.

FIGURE 3

CALCULATION OF PROPORTION OF DWELLING UNITS BY TYPE

Proportion Mobile Homes = $0.025896 -$
Average Residential Density $\times .001954$

Proportion Single Family = $0.963769 -$
Average Residential Density $\times 0.036455$

TABLE 16

YEAR 2000 TOTAL SUSPENDED PARTICULATE EMISSIONS FROM RESIDENTIAL SOURCES
(In Millions of Pounds)

(For Comparison Purposes Only)

Electricity Fuel Oil Natural Gas Total

Alternative 1	Mobile Home	1.20	.04	.04	1.28
	1-Family	116.42	3.45	3.83	123.50
	2-Family	13.25	.39	.41	14.05
	Multi-Family	10.01	.21	.75	10.97
	Total	140.88	4.09	4.83	149.80
Alternative 2	Mobile Home	1.14	.04	.04	1.22
	1-Family	113.82	3.37	3.55	120.74
	2-Family	14.81	.44	.46	15.71
	Multi-Family	10.74	.23	.80	11.77
	Total	140.51	4.08	4.85	149.44
Alternative 3	Mobile Home	1.17	.04	.04	1.25
	1-Family	114.68	3.39	3.57	121.64
	2-Family	13.85	.41	.43	14.69
	Multi-Family	10.26	.22	.77	11.25
	Total	139.96	4.06	4.81	148.83
Alternative 4	Mobile Home	1.23	.04	.04	1.31
	1-Family	118.64	3.51	3.70	125.85
	2-Family	13.62	.40	.42	14.44
	Multi-Family	10.26	.22	.77	11.25
	Total	143.75	4.17	4.93	152.85
Alternative 5	Mobile Home	1.26	.04	.04	1.34
	1-Family	119.31	3.53	3.72	126.56
	2-Family	12.27	.36	.38	13.01
	Multi-Family	9.57	.21	.72	10.50
	Total	142.41	4.14	4.86	151.41
Alternative 6	Mobile Home	1.19	.04	.04	1.27
	1-Family	115.65	3.42	3.60	122.67
	2-Family	13.49	.40	.42	14.31
	Multi-Family	10.10	.22	.76	11.08
	Total	140.43	4.08	4.82	149.33

TABLE 17

YEAR 2000 CARBON MONOXIDE EMISSIONS FROM RESIDENTIAL SOURCES

(In Millions of Pounds)
(For Comparison Purposes Only)

		Electricity	Fuel Oil	Natural Gas	Total
Alternative 1	Mobile Home	.09	.02	.08	.19
	1-Family	8.46	1.72	7.25	17.43
	2-Family	.96	.20	.83	1.99
	Multi-Family	.73	.11	1.50	2.34
	Total	10.24	2.05	9.66	21.95
Alternative 2	Mobile Home	.08	.02	.07	.17
	1-Family	8.27	1.68	7.09	17.04
	2-Family	1.08	.22	.92	2.22
	Multi-Family	.78	.12	1.61	2.51
	Total	10.21	2.04	9.69	21.94
Alternative 3	Mobile Home	.09	.02	.08	.19
	1-Family	8.33	1.70	7.15	17.18
	2-Family	1.01	.20	.86	2.07
	Multi-Family	.75	.11	1.52	2.38
	Total	10.18	2.03	9.61	21.82
Alternative 4	Mobile Home	.09	.02	.08	.19
	1-Family	8.62	1.76	7.39	17.77
	2-Family	.99	.20	.85	2.04
	Multi-Family	.75	.11	1.53	2.39
	Total	10.45	2.09	9.85	22.39
Alternative 5	Mobile Home	.09	.02	.08	.19
	1-Family	8.67	1.77	7.44	17.88
	2-Family	.89	.18	.76	1.83
	Multi-Family	.70	.10	1.43	2.23
	Total	10.35	2.07	9.71	22.13
Alternative 6	Mobile Home	.09	.02	.08	.19
	1-Family	8.40	1.71	7.21	17.32
	2-Family	.98	.20	.84	2.02
	Multi-Family	.73	.11	1.51	2.35
	Total	10.20	2.04	9.64	21.88

TABLE 18

YEAR 2000 SULFUR OXIDE EMISSIONS FROM RESIDENTIAL SOURCES
(In Millions of Pounds)
(For Comparison Purposes Only)

		Electricity	Fuel Oil	Natural Gas	Total
Alternative 1	Mobile Home	6.28	.18	0	6.46
	1-Family	609.24	14.91	.22	624.37
	2-Family	69.32	1.70	.02	71.04
	Multi-Family	52.36	.94	.04	53.34
	Total	737.20	17.73	.28	755.21
Alternative 2	Mobile Home	5.97	.16	0	6.13
	1-Family	595.66	14.58	.21	610.45
	2-Family	77.48	1.90	.03	79.41
	Multi-Family	56.21	1.01	.05	57.27
	Total	735.32	17.65	.29	753.26
Alternative 3	Mobile Home	6.12	.17	0	6.29
	1-Family	600.13	14.69	.21	615.03
	2-Family	72.46	1.77	.03	74.26
	Multi-Family	53.69	.97	.05	54.71
	Total	732.40	17.60	.29	750.29
Alternative 4	Mobile Home	6.44	.18	0	6.62
	1-Family	620.86	15.19	.22	636.27
	2-Family	71.28	1.74	.03	73.05
	Multi-Family	53.69	.97	.05	54.71
	Total	752.27	18.08	.30	770.65
Alternative 5	Mobile Home	6.59	.18	0	6.77
	1-Family	624.39	15.28	.22	639.89
	2-Family	64.21	1.57	.02	65.80
	Multi-Family	50.08	.90	.04	51.02
	Total	745.27	17.93	.28	763.48
Alternative 6	Mobile Home	6.20	.17	0	6.37
	1-Family	605.24	14.81	.22	620.27
	2-Family	70.57	1.73	.03	72.33
	Multi-Family	52.83	.95	.05	53.83
	Total	734.84	17.66	.30	752.80

TABLE 19

YEAR 2000 NITROGEN OXIDE EMISSIONS FROM RESIDENTIAL SOURCES

(In Millions of Pounds)
(For Comparison Purposes Only)

		Electricity	Fuel Oil	Natural Gas	Total
Alternative 1	Mobile Home	4.61	.05	.39	5.05
	1-Family	447.81	4.14	36.27	488.22
	2-Family	50.95	.47	4.13	55.55
	Multi-Family	38.49	.26	7.49	46.24
	Total	541.86	4.92	48.28	595.06
Alternative 2	Mobile Home	4.39	.05	.37	4.81
	1-Family	437.83	4.04	35.47	477.34
	2-Family	56.95	.53	4.61	62.09
	Multi-Family	41.31	.28	8.04	49.63
	Total	540.48	4.90	48.49	593.87
Alternative 3	Mobile Home	4.50	.05	.38	4.93
	1-Family	441.12	4.07	35.73	480.92
	2-Family	53.26	.50	4.32	58.08
	Multi-Family	39.47	.27	7.69	47.43
	Total	538.35	4.89	48.12	591.36
Alternative 4	Mobile Home	4.73	.05	.40	5.18
	1-Family	456.35	4.21	36.96	497.52
	2-Family	52.39	.48	4.24	57.11
	Multi-Family	39.47	.27	7.67	47.41
	Total	552.94	5.01	49.27	607.22
Alternative 5	Mobile Home	4.85	.05	.41	5.21
	1-Family	458.95	4.24	37.18	500.37
	2-Family	47.20	.44	3.82	51.46
	Multi-Family	36.81	.25	7.17	44.23
	Total	547.81	4.98	48.58	601.27
Alternative 6	Mobile Home	4.56	.05	.39	5.00
	1-Family	444.87	4.11	36.04	485.02
	2-Family	51.87	.48	4.20	56.55
	Multi-Family	38.83	.26	7.56	46.65
	Total	540.13	4.90	48.19	593.22

TABLE 20

YEAR 2000 HYDROCARBON EMISSIONS FROM RESIDENTIAL SOURCES
(In Millions of Pounds)
(For Comparison Purposes Only)

		Electricity	Fuel Oil	Natural Gas	Total
Alternative 1	Mobile Home	.03	.01	.03	.07
	1-Family	2.73	1.03	2.90	6.66
	2-Family	.31	.12	.33	.76
	Multi-Family	.23	.07	.60	.90
	Total	3.30	1.23	3.86	8.39
Alternative 2	Mobile Home	.03	.01	.03	.07
	1-Family	2.67	1.01	2.84	6.52
	2-Family	.35	.13	.37	.85
	Multi-Family	.25	.07	.64	.96
	Total	3.30	1.22	3.88	8.40
Alternative 3	Mobile Home	.03	.01	.03	.07
	1-Family	2.69	1.01	2.86	6.56
	2-Family	.32	.12	.35	.79
	Multi-Family	.24	.07	.61	.92
	Total	3.28	1.21	3.85	8.34
Alternative 4	Mobile Home	.03	.01	.03	.07
	1-Family	2.78	1.05	2.96	6.79
	2-Family	.32	.12	.34	.78
	Multi-Family	.24	.07	.61	.92
	Total	3.37	1.25	3.94	8.56
Alternative 5	Mobile Home	.03	.01	.03	.07
	1-Family	2.80	1.06	2.97	6.83
	2-Family	.29	.11	.31	.71
	Multi-Family	.22	.06	.57	.85
	Total	3.34	1.24	3.88	8.46
Alternative 6	Mobile Home	.03	.01	.03	.07
	1-Family	2.71	1.03	2.88	6.62
	2-Family	.32	.12	.34	.78
	Multi-Family	.24	.07	.60	.91
	Total	3.30	1.23	3.85	8.38

Proportion Two Family = $-0.017599 +$
Average Residential Density $\times 0.021562$

Proportion Multi Family = $0.029124 +$
Average Residential Density $\times 0.017367$

Energy use profiles were developed by taking into consideration the average amount of fuel oil, gas and electricity consumed each year by dwelling units in each type. The profiles appear in Table 21. The average number of dwelling units in each building type was multiplied by the average consumption factor for fuel oil, gas and electricity² to get the total energy consumption by fuel type for the region in 2000.

TABLE 21
AVERAGE YEARLY RESIDENTIAL ENERGY CONSUMPTION
IN MILLIONS OF BTUs BY FUEL TYPE

Building Type	Electricity	Fuel Oil	Natural Gas
Mobile Home	23.0	16.2	112.0
Single Family	46.0	28.6	215.0
Two-Family	46.0	28.6	215.0
Multi-Family	26.9	12.3	302.0

Factors were applied to the amount of energy consumed to estimate the amount of air pollutants generated by each alternative. These factors related pollutant levels to the amount of BTUs consumed in each fuel type. Table 4 present these factors.³ Each set of factors was multiplied by the amount of energy consumed in each fuel type to drive the total level of each pollutant in 2000 for each alternative.

TABLE 22
POLLUTANTS IN POUNDS PER BTU CONSUMED

Pollutant	Fuel Oil	Fuel Oil Natural Gas	Electricity
Particulates	7.14×10^{-8}	1.00×10^{-8}	1.50×10^{-6}
Sulphur Oxides	3.09×10^{-7}	6.00×10^{-10}	7.85×10^{-6}
Carbon Monoxide	3.57×10^{-8}	2.00×10^{-8}	1.09×10^{-7}
Hydrocarbons	2.14×10^{-8}	8.00×10^{-9}	3.52×10^{-8}
Nitrogen Oxides	8.57×10^{-8}	1.00×10^{-7}	5.77×10^{-6}

MOBILE SOURCE ENERGY CONSUMPTION

Land use and regional development patterns affect the amount of travel that takes place within the region and consequently affects the amount of energy consumed by motor vehicles in the region. To determine how each of the SAF alternatives are likely to affect transportation in the region, the Transportation Integrated Modeling System (TRIMS) was used. Results from TRIMS were then used to calculate mobile source energy consumption.

The bottom line in Table 23 shows the results of this analysis for each alternative. Under all alternatives, the total energy consumed in the region declines from the week day average of 483 billion BTUs used in 1970. Alternative 6 achieves the greatest energy savings with an average week day consumption of 450 billion BTUs. Alternative 4 produces the greatest energy use at 490 billion BTUs. Of the remaining alternatives, Alternative 1 is next lowest in energy requirement, while Alternative 5 is next highest.

It is interesting to note that under all alternatives the average vehicle miles traveled per week day increases substantially over the 1970 total. This means that the bulk of energy savings is achieved through reduction in the amount of fuel consumed per vehicle.

Table 23 also indicates how the results for energy consumption were derived. The first line in the table shows the total vehicle miles traveled for each alternative based on the TRIMS results. The second line is the average fuel economy for vehicles traveling in the region in 1970 and the year 2000. The values in the third line are the figures in the second line converted from miles per gallon to gallons per mile. The figures in the fourth line are the product of the corresponding figures in the first and third lines. Finally, the fifth line converts gallons of gasoline burned into BTUs.

TABLE 23

YEAR 2000 REGIONWIDE MOBILE SOURCE ENERGY CONSUMPTION
 PER AVERAGE WEEKDAY
 (Passenger Vehicles Only)

	1970	Alternative					
	Base	1	2	3	4	5	6
Vehicle Miles Traveled (x10 ³)	58305	97133	99348	99283	105525	100701	97193
Average Vehicle Economy ¹ (miles per gallon)	15.4	27.5	27.5	27.5	27.5	27.5	27.5
Average Vehicle Consumption (gal/mile)	.064	.0364	.0364	.0364	.0364	.0364	.0364
Gallons of Gasoline Consumed (10 ³)	3784	3535	3616	3613	3841	3665	3537
BTUs Consumed ² (10 ⁶)	483000	451000	460000	460000	490000	470000	450000

¹The year 2000 passenger vehicle fleet will theoretically achieve the mandated 27.5 mpg fuel economy standard through the attrition of vehicles with pre-1985 technology. Vehicles not achieving the 1985 standard of 27.5 mpg will not account for an significant percentage of the year 2000 fleet, probably less than one per cent.

²One gallon of gasoline is equal to 127,650 BTUs.

POLLUTANT LOADINGS GENERATED FROM MOBILE SOURCE ENERGY CONSUMPTION

Regional air pollution levels are greatly affected by mobile source emissions. Because energy consumption varies under each of the SAF alternatives, it is likely that air pollutant loadings from mobile sources would vary also. To determine how greatly the alternative might vary, the regional pollutant loadings for carbon monoxide, nitrite oxide, and hydrocarbons produced by vehicles in the region were calculated for each alternative.

Since the consumption of motor fuels declines in the region under all alternatives, and because of the expected reductions in vehicular emissions that will result from automotive engine modifications called for by the Clean Air Act, pollutant levels are expected to be lower in 2000 than in 1970 under all alternatives. Still, these pollutant levels may exceed standards currently mandated by recent amendments to the Clean Air Act, since vehicle miles traveled in 2000 are projected to exceed 1970 levels. For all pollutants, there is at most a four percent difference between alternatives.

Table 24 presents the results of these calculations. Since the consumption of motor fuels declines in the region under all alternatives, and because of the expected reductions in vehicular emissions that will result from the implementation of the Clean Air Act, pollutant loadings are expected to be much lower than in 1970 under all alternatives. The greatest reduction in all pollutants occurs under Alternative 1, followed closely by Alternative 6. Alternatives 4 and 5 achieve the least reduction, mostly because they generate greater demands for travel. For all pollutants, there is at most a four percent difference between alternatives in the amount loadings are reduced.

The results of this analysis were derived using a three step process based on the vehicle miles traveled under each alternative. First, emission factors were determined for passenger cars, light trucks, and heavy, diesel fueled trucks. These factors are presented in Table 25. Second, the composition of the fleet of vehicles traveling in the region in the year 2000 was determined to be:

Passenger Cars	84.5%
Light Trucks	9.7%
Heavy, Gasoline Fueled Trucks	3.5%
Heavy, Diesel Fueled Trucks	2.3%

These percentages then were used to calculate the total number of vehicle miles traveled by vehicles in each type in eight different speed classes. Miles traveled per speed class are provided by TRIMS as model output. The miles traveled by each vehicle type in each speed class were then multiplied by a speed adjustment factor and the appropriate emissions factor. The speed adjustment factors reflect the levels of emissions that

TABLE 24

YEAR 2000 REGIONWIDE MOBILE SOURCE EMISSIONS
PER AVERAGE WEEKDAY

	1970 Base	Alternative					
		1	2	3	4	5	6
Vehicle Miles Traveled (x10 ³)	66225	111359	113420	113726	119956	115300	111380
Carbon Monoxide (kg)	2062490	461335	470100	470319	486565	374515	461653
Nitrite Oxide (kg)	466492	229379	233596	234435	248735	238168	229423
Hydrocarbons (kg)	416317	95223	97013	97126	101219	98044	95263

NOTE: VMT includes load-links.

TABLE 25

POLLUTANT EMISSION FACTORS BY VEHICLE TYPE
(Figures are in Grams per Vehicle Mile Traveled)

Pollutant	Vehicle Type			
	Passenger Car	Light Truck	Heavy, Gasoline Fueled Truck	Heavy, Diesel Fueled Truck
Carbon Monoxide	3.88	14.13	121.03	28.70
Nitrite Oxide	0.65	2.51	12.99	20.20
Hydrocarbons	0.98	2.37	9.02	4.60

TABLE 26

SPEED ADJUSTMENT FACTORS

Speed Range	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60
Carbon Monoxide	0.86	0.68	0.57	0.48	0.43	0.39	0.37	0.34
Nitrite Oxide	1.03	1.07	1.11	1.15	1.19	1.23	1.27	1.31
Hydrocarbons	0.89	0.77	0.68	0.62	0.58	0.55	0.52	0.49

are produced at each speed range. The factors used appear in Table 26. Air pollutant loadings were then summed for each pollutant across each vehicle type and speed class to determine total emissions.

WATER QUALITY: THE SEM-STORM RESULTS

A major determinant of regional water quality is the quantity and pollution loading of storm water runoff. Land use patterns and the density of development are two factors which affect storm water runoff, and consequently impact regional water quality. To determine what impact the land use policies incorporated in the six SAF alternatives might have on regional water quality, the SEM-STORM⁴ water quality model was used to evaluate SAF results.

Table 27 presents the annual nonpoint loadings of suspended solids for each analysis unit and the region as a whole by alternative. Alternative 4 produces the least amount of the alternatives, effectively maintaining the 1975 loadings of just over 92,000 tons. Alternative 5 generates the greatest loadings with a total close to 105,000 tons. The remaining alternatives generate roughly the same loadings, ranging from slightly over 97,000 tons under Alternative 2 to more than 102,000 tons under Alternative 3.

The reasons that there is not a greater difference between Alternatives 1, 3 and 6 is due to the nature of development in the region. Under all of these alternatives, vacant and agricultural land is converted to low density residential land uses. Both of the land uses generate about the same amount of suspended solids.⁵ Thus, although land is converted to more urban uses under each alternative, there is still not much change in total loadings.

Although the amount of suspended solids do not vary much among the alternatives, the proportion that is generated from urbanized area does. This would not be significant if storm water runoff in rural areas was the same as that found in urban areas, but this is not the case. Urban runoff typically contains higher loadings of phosphorus and lead than runoff in rural areas. Thus, it is desirable to minimize the amount of storm runoff in urban areas.

Table 28 shows the annual tons nonpoint suspended solids originating from urban areas by each analysis unit. The percentage change in the total from 1975 to 2000 is also included in the table. Since Alternative 2 and 4 develop the least amounts of agricultural and vacant land, they generate the least urban runoff. In general, Alternative 4 produces the least urban runoff in the more urbanized watersheds, while Alternative 2 produces the least in the watersheds that contain comparatively little urban development. Alternative 3 ranks third in reducing urban runoff, although some basins, notably the more urban basins, do better under Alternatives 1 and 5.

With respect to individual basins, the results show little difference among alternatives for some, and quite a bit for others. Generally, there

TABLE 27
YEAR 2000 NON-POINT SUSPENDED
SOLIDS BY BASIN (In Tons)

Basin	Source	1975 Base	Alternative					
			1	2	3	4	5	6
Detroit	Urban	6250.7	5860.7	5566.9	5751.4	5714.4	5449.5	5751.4
	Non-Urban	23.3	25.5	28.6	29.5	34.2	31.2	26.0
Rouge - CSO	Urban	5005.3	4850.3	4869.3	4871.0	4641.9	4638.0	4889.9
	Non-Urban	20.4	23.2	19.8	22.2	35.3	26.8	22.4
Upper Rouge	Urban	1636.1	2738.2	2347.7	2663.8	1995.5	2725.4	2592.2
	Non-Urban	977.5	713.4	856.6	789.0	894.6	707.0	737.1
Middle Rouge	Urban	1008.8	1685.2	1473.7	1733.5	1358.0	1734.1	1787.0
	Non-Urban	99.5	66.8	87.8	84.7	82.9	62.9	60.6
Lower Rouge	Urban	509.2	904.0	856.1	839.4	688.5	824.8	892.6
	Non-Urban	1372.3	1185.5	1198.9	1211.3	1266.5	1218.9	1170.3
Upper Mainstream Rouge	Urban	2383.3	3454.3	2967.8	3569.7	2671.8	3474.6	3512.1
	Non-Urban	68.5	41.1	51.9	61.3	58.5	43.6	40.4
Downriver	Urban	2798.2	3759.0	3303.9	3503.1	3042.4	3423.6	3479.8
	Non-Urban	653.2	511.6	567.4	536.9	611.8	549.0	537.2
Lower Huron	Urban	352.9	1003.7	612.4	1017.6	499.7	835.4	915.4
	Non-Urban	1428.6	1002.5	1222.9	1012.5	1293.3	1090.9	1043.3
Huron Headwaters	Urban	769.3	2541.2	1509.9	2561.9	963.8	3871.6	3124.9
	Non-Urban	1408.7	1129.4	1401.7	1472.8	1381.3	876.6	1102.0
Ann Arbor-Ypsilanti	Urban	823.2	1365.5	933.7	1179.6	1143.8	1743.0	1409.1
	Non-Urban	5598.6	5076.4	5542.0	5317.1	5303.2	4736.9	5039.8
Huron Lakes	Urban	108.6	440.7	169.1	402.7	140.6	859.1	643.1
	Non-Urban	2634.7	2366.6	2596.6	2539.4	2566.4	2186.1	2244.7
Twelve Towns Drain	Urban	1931.1	1988.1	1943.6	1945.7	1888.9	1917.4	1955.1
	Non-Urban	6.1	4.3	6.0	4.6	6.9	5.1	4.6
Red Run	Urban	3515.4	5224.0	4549.9	5004.0	3866.5	5046.1	5075.7
	Non-Urban	149.2	64.8	129.6	134.2	126.7	66.8	74.8
Clinton Headwaters	Urban	2191.2	4185.5	3344.8	3449.7	2454.3	4206.5	4044.5
	Non-Urban	603.1	351.2	553.0	675.9	546.9	337.4	394.4
Paint Creek	Urban	367.0	1311.7	574.0	1051.5	404.4	2643.3	948.8
	Non-Urban	183815	1425.2	1842.0	1895.6	1748.2	1018.4	1555.8
Middle Clinton	Urban	317.7	765.4	505.2	783.9	381.2	715.3	816.9
	Non-Urban	434.0	361.4	407.8	351.8	413.6	364.2	349.4
North Clinton	Urban	294.8	454.1	401.9	405.9	408.9	466.8	455.6
	Non-Urban	2712.0	2548.2	2685.9	2607.5	2568.8	2519.8	2571.0
Stoney Creek	Urban	200.0	1111.4	353.2	1280.1	366.7	1345.3	1089.0
	Non-Urban	5846.6	4817.3	5554.0	4680.1	5562.1	4709.3	4849.7
River Raisin	Urban	124.8	590.3	182.2	558.6	322.0	1026.7	588.0
	Non-Urban	8020.4	7205.2	7902.8	7237.1	7652.5	6815.9	7215.4

continued

TABLE 27 (Continued)

Basin	Source	1975 Base	Alternative					
			1	2	3	4	5	6
Otter Creek	Urban	211.9	1542.3	329.1	1660.2	324.9	1675.4	1192.8
	Non-Urban	4429.9	3297.3	4225.9	3230.3	4232.6	3378.5	3539.2
Salt	Urban	502.2	939.9	712.8	949.5	754.0	1032.3	1029.4
	Non-Urban	1795.4	1608.3	1744.1	1600.2	1614.8	1546.7	1589.1
Belle	Urban	78.4	300.2	109.7	191.2	185.2	404.0	255.8
	Non-Urban	3889.9	3559.2	3860.5	3689.9	3685.7	3459.8	3616.5
Pine	Urban	208.5	748.1	290.4	353.6	339.7	892.6	628.2
	Non-Urban	3873.0	3373.2	3830.2	3689.7	3678.1	3259.1	3475.8
Black	Urban	271.7	494.3	391.2	434.9	684.5	573.4	494.2
	Non-Urban	3371.2	3176.4	3381.8	3221.7	3010.6	3114.4	3165.7
Lake Huron	Urban	22.5	52.6	26.8	52.3	58.7	69.9	79.8
	Non-Urban	853.0	816.1	849.4	830.0	800.2	797.1	791.2
Shiawassee	Urban	183.4	992.8	322.7	980.6	290.6	4191.9	1016.0
	Non-Urban	5833.2	5217.5	5916.4	6001.7	5724.4	3909.9	5228.5
Red Cedar	Urban	19.7	79.8	23.2	46.2	37.7	428.5	107.0
	Non-Urban	2111.1	1996.7	2110.6	2126.6	2062.0	1724.0	1957.6
REGION	Urban	32085.9	49383.3	38671.2	47241.6	35628.6	56214.5	48774.3
	Non-Urban	60051.9	51964.3	58511.2	55053.6	56912.1	48556.3	52402.5

TABLE 28
YEAR 2000 URBAN NON-POINT SUSPENDED
SOLIDS LOADINGS BY BASIN (In Tons)

(Figures in Parentheses are Per Cent Change from 1975)

Basin	1975 Base	Alternative					
		1	2	3	4	5	6
Detroit	6250.7	5860.7 (-6.24)	5566.9 (-10.94)	5751.4 (-7.99)	5714.4 (-8.58)	5449.5 (-12.82)	5751.4 (-7.99)
Rouge	9006.3	4850.3 (-3.10)	4869.3 (-2.72)	4871.0 (-2.68)	4641.9 (-7.26)	4638.0 (-7.34)	4869.9 (-2.31)
Upper Rouge	1636.1	2738.2 (67.36)	2347.7 (43.49)	2663.8 (62.81)	1995.5 ^N (21.97)	2725.4 (66.58)	2592.2 (58.44)
Middle Rouge	1008.8	1685.2 (67.05)	1473.7 (46.08)	1733.5 (71.84)	1358.0 (34.62)	1734.1 (71.90)	1787.0 (77.14)
Lower Rouge	509.2	904.0 (77.53)	856.1 (68.13)	839.4 (64.85)	688.5 (35.21)	824.8 (61.98)	892.6 (75.29)
Upper Mainstream Rouge	2383.3	3454.3 (44.94)	2967.8 (24.52)	3569.7 (49.78)	2671.8 (12.11)	3474.6 (45.79)	3512.1 (47.36)
Downriver	2798.2	3759.0 (34.34)	3303.9 (18.07)	3503.1 (25.19)	3042.4 (8.73)	3423.6 (22.35)	3479.8 (24.36)
Lower Huron	352.9	1003.7 (184.41)	612.4 (73.53)	1017.6 (188.35)	499.7 (41.60)	835.4 (136.72)	915.4 (159.39)
Huron Headwaters	769.3	2541.2 (230.33)	1509.9 (96.27)	2561.9 (233.02)	963.8 (25.28)	3871.6 (403.26)	3124.9 (306.20)
Ann Arbor-Ypsilanti	823.2	1365.5 (65.88)	933.7 (13.42)	1179.6 (43.29)	1143.8 (38.95)	1743.0 (111.73)	1409.1 (71.17)
Huron Lakes	108.6	440.7 (305.80)	169.1 (55.71)	402.7 (270.81)	140.6 (29.47)	859.1 (691.07)	643.1 (492.17)
Twelve Towns Drain	1931.1	1988.1 (2.95)	1943.6 (.65)	1945.7 (.76)	1888.9 (-2.19)	1917.4 ^b (-.71)	1955.1 (1.24)
Red Run	3515.4	5224.0 (48.60)	4549.9 (29.43)	5004.0 (42.35)	3866.5 (9.99)	5046.1 (43.54)	5075.7 (44.38)
Clinton Headwaters	2191.2	4185.5 (91.01)	3344.8 (52.65)	3449.7 (57.43)	2454.3 (12.01)	4206.5 (91.97)	4044.5 (84.58)
Paint Creek	367.0	1311.7 (257.41)	574.0 (56.40)	1051.5 (186.51)	404.4 (10.19)	2843.3 (620.25)	948.8 (158.53)
Middle Clinton	317.7	765.4 (140.92)	505.2 (59.02)	783.9 (146.74)	381.2 (19.99)	715.3 (125.15)	816.9 (157.13)
North Clinton	294.8	454.1 (54.04)	401.9 (36.33)	405.9 (37.69)	408.9 (38.70)	466.8 (58.34)	455.6 (54.55)
Stoney Creek	200.0	1111.4 (455.70)	353.2 (76.60)	1280.1 (540.05)	366.7 (83.35)	1345.3 (572.65)	1089.0 (444.50)
River Raisin	124.8	590.3 (373.00)	182.2 (45.99)	558.6 (347.60)	322.0 (158.01)	1028.7 (722.68)	588.0 (371.15)
Otter Creek	211.9	1542.3 (627.84)	329.1 (55.31)	1660.2 (683.48)	324.9 (53.33)	1675.4 (690.66)	1192.8 (462.91)

TABLE 28 (Continued)

Basin	1975 Base	Alternative					
		1	2	3	4	5	6
Salt	502.2	939.9 (87.16)	712.8 (41.94)	949.5 (89.07)	754.0 (50.14)	1032.3 (105.56)	1029.4 (104.98)
Belle	78.4	300.2 (282.91)	109.7 (39.92)	191.2 (143.88)	185.2 (136.22)	404.0 (415.31)	255.8 (226.28)
Pine	208.5	748.1 (258.80)	290.4 (39.28)	353.6 (69.59)	339.7 (62.93)	892.6 (328.11)	628.2 (201.29)
Black	271.7	494.3 (87.93)	391.2 (43.98)	434.9 (60.07)	684.5 (151.93)	573.4 (111.04)	494.2 (81.89)
Lake Huron	22.5	52.6 (133.78)	26.8 (19.11)	52.3 (132.44)	58.7 (160.89)	69.9 (210.67)	79.8 (254.67)
Shiawassee	183.4	992.8 (441.33)	322.7 (75.95)	980.6 (434.68)	290.6 (58.45)	4191.9 (2185.66)	1016.0 (453.98)
Red Cedar	19.7	79.8 (305.08)	23.2 (17.77)	46.2 (134.52)	37.7 (91.37)	428.5 (2075.13)	107.0 (443.15)
REGION	32085.9	49383.3 (53.91)	38671.2 (20.52)	47241.6 (47.23)	35628.6 (11.04)	56214.5 (75.20)	48774.3 (52.01)

is little difference in the Detroit Rouge and Twelve Towns basins in which the older urban areas are located. This is because these basins are almost fully developed, and remain so under all the alternatives.

Moreover, in a large number of basins, the difference between the lowest and the highest nonpoint loading in any basin is not great. This difference is not considered great because the actual pollutant loadings in an area will be determined by the site planning associated with the development. The basins (see Figure 4) in this category are:

Upper Rouge,
Upper Mainstream Rouge,
Middle Rouge,
Downriver,
Lower Huron,
Salt, and
Black.

In all but the last two of these basins, Alternative 4 produces the least loading followed by Alternative 2. For the Salt and Black basins, this result is reversed. In the remaining basins, however, there is a considerable range of estimated pollutant loadings between the alternatives. The areas where such impacts are greatest is in basins which have hydrologically "closed" lake watersheds; in these systems the impacts of storm water pollutant loadings tend to accumulate over time. Thus, basins with lakes whose watersheds are developed by 2000 may experience water quality problems. These areas, as shown in Figure 4, include:

Huron Headwaters,
Huron Lakes,
Clinton,
Shiawassee, and
Red Cedar.

In these basins, it is thought that regardless of the kind of water quality protection that may be designed into commercial and residential developments, there is a substantial difference in alternative forecasts. In these areas, Alternative 3 generates the least pollutants after the high density Alternatives 2 and 4.

In conclusion, the alternatives that encourage high density residential development generate the least pollutant loads in storm water runoff. Alternative 4 which spreads new development more evenly throughout the region has the least effect on water quality overall. However, this is

A detailed map of the Detroit River Basin area, showing various river basins, rivers, and sub-basins. The map includes labels for locations such as PARY-STONEY CREEK, HEADWATER LAURON, UPPER BARTEM, TWELVE TOWNS, DETROIT, HAMILTON, and ST. CLAIR. A legend indicates that solid lines represent RIVER BASINS, double lines represent RIVERS, and dashed lines represent SUB-BASINS. The map also shows the Detroit River, Lake St. Clair, and Lake Erie.

achieved by increasing the urban nonpoint loadings in areas that are currently relatively free of nonpoint pollutants.

Alternative 2 concentrates urban runoff in areas where nonpoint pollution problems already exist. If treatment of storm water runoff becomes practical, it would be desirable if such pollution were concentrated so that it could be treated more economically. Thus, in the long run, Alternative 2 appears to be the most attractive alternative, as it has few negative impacts on water quality and the problems caused by development are more manageable.

THE SEM-STORM WATER QUALITY MODEL

For the SEM-STORM water quality analysis, the region was divided into 27 units based on the boundaries of watersheds, river basins and sub-basins in the region. These units are shown in Figure 4. As can be seen in the figure, the larger river basins such as the Clinton Basin were divided into as many as five analysis units.

Land use information generated by the SAF alternatives for each of the 1,446 small areas in the region was aggregated to each watershed analysis unit. This information was combined with regional soils data and a rainfall history for Southeast Michigan. Runoff coefficients were calculated for each analysis unit using the land use and soils data, and annual runoff was computed based on the runoff coefficient and rainfall history. Pollutant loads for each of the watershed analysis units were calculated based on the amount of runoff and the configuration of land uses in each basin, using the SEM-STORM Water Quality Model.

The actual mechanics of the SEM-STORM model are presented in much greater detail in Computer Program Documentation for the Continuous Storm Runoff Model SEM-STORM.

It should be noted that this procedure does not estimate the loadings of some forms of nonpoint pollution such as those produced by septic tank disposal systems, or certain kinds of agricultural operations such as feedlots. A more detailed presentation of the method used in the analysis appears in Consequence of a "No Action Alternative" on Urban Pollution in Southeast Michigan,⁶ a background paper on the impacts of projected urban development in the Clinton, Rouge, and Huron Rivers.

FOOTNOTES: CHAPTER III

¹ These factors were provided by Decision Sciences Corporation.

² Ibid.

³ Ibid.

⁴Davis, L.C., et. al., Model Calibration and Validation: QUAL-II, SEM-STORM, AND RUNQUAL, prepared by Water Resources Engineers, Inc., Walnut Creek, California, for Southeast Michigan Council of Governments, Detroit, Michigan, December, 1977.

⁵This water quality model is a planning level model designed for comparing land use impacts on water quality. The model is documented in Shulsinski, R.P., A.J. Knepp, and C.R. Bristol, Computer Program Documentation for the Continuous Storm Runoff Model SEM-STORM.

⁶Collins, P.G., Consequences of a "No Action Alternative" on Urban Non-Point Pollution in Southeast Michigan, Southeast Michigan Council of Governments, Detroit, Michigan, March, 1978.

CHAPTER IV: TRANSPORTATION

TRIMS MODEL RUN: RESULTS

To the extent regional development policies influence the location of households and firms, they also affect transportation systems in the region. The Transportation Integrated Modeling System (TRIMS)¹ was used to evaluate the impacts of each of the six regional policy alternatives on transportation demand. The modeling system accounted for the locations of households and firms in estimating the volume, length and mode of work trips in the region for an average work day.

Under every alternative, the average work length and total Vehicle Miles of Travel (VMT) are forecast to be higher in the year 2000 than in 1970. This occurs because households become more dispersed throughout the region over the forecast period while little change occurs in the location of basic employment. This means that the mileage and time of the average trip to work will increase.

As Table 29 illustrates, Alternatives 1 and 6 produce the lowest daily VMT of 97,100,000 miles. Alternative 4 produces the highest VMT, 105,500,000 miles. Alternatives 1 and 6 represent a 66 percent increase over the 1970 amount while Alternative 4 represents an 81 percent increase.

The time of the average work trip, shown in Table 30, follows the VMT pattern. Trips are fastest under Alternatives 1 and 6, and slowest under Alternative 4. Trip time is a direct indicator of distance for all trips, as TRIMS assignments are not adjusted for delays due to congestion.

Job accessibility was measured in terms of the percentage of jobs within 45 minutes of the average household. Table 31 shows that accessibility is practically constant for all alternatives except 4, which shows a marked decrease in accessibility for both highway and transit work trips. All the alternatives show a decrease in job accessibility from 1970.

The proportion of work trips involving some form of public transit decreases under all alternatives from 8.2 percent share in 1970. Table 32 shows that the market share for the year 2000 ranges from a minimum of 4.9 percent under Alternative 4 to a maximum of 5.9 percent reached under Alternatives 1, 2, 3 and 6.

In absolute terms, the number of transit passengers increases a maximum of ten percent from 1970 while automobile travel increases a minimum of 54 percent, or 10,644 trips.

TABLE 29

YEAR 2000 TOTAL VEHICLE MILES OF TRAVEL
(Figures are in Thousands of Miles)

1970 Base	Alternative					
	1	2	3	4	5	6
58305	97133	99348	99283	105525	100701	97193

TABLE 30

YEAR 2000 AVERAGE WORK TRIP LENGTH IN MINUTES BY MODE

Mode	1970 Base	Alternative					
		1	2	3	4	5	6
Auto Person Trips	24.0	26.1	26.3	26.2	30.1	27.0	26.1
Transit Passenger Trips	45.2	53.0	53.6	52.9	60.4	55.5	52.8

TABLE 31

YEAR 2000 PERCENT OF JOBS WITHIN 45 MINUTES BY NETWORK TYPE

Network	1970 Base	Alternative					
		1	2	3	4	5	6
Highway	74	59	61	59	49	56	59
Transit	16	9	9	9	7	8	9

NB: Figures based on existing 1975 highway network with freeways under construction added;
and on 1975 existing all-bus transit system.

The percent of transit trips bound for the Detroit CBD also decreases from a 1970 level of 17.6 percent. Of all the alternatives, 1 and 6 show the greatest number of CBD-bound transit trips, a show of 14.6 percent of total work trips. Alternative 4 is lowest with a 12 percent share. The distribution of CBD work trips between automobile and transit passengers is shown in Table 33.

It should be noted that the transit system analyzed in the TRIMS run was that existing as of 1975. The low accessibility shown on Table 31 is therefore due in part to a failure of the transit service area to expand as households and employment become more dispersed over the forecast period. Likewise, the low mode split shown in Table 32 and 33 is based on an all-bus network limited to the 1975 service area. The expanded transit network resulting from alternatives analysis would produce considerably higher accessibility.

Table 34 presents the trip orientation under each alternative. Between 1970 and 2000 there is less orientation of suburban trips to the City of Detroit and more emphasis on City of Detroit trips to the suburbs. Increases in travel to the core is a direct result of increases in Central Business District employment. Travel demand on a county level is assumed to vary in the same proportion as the growth in households and jobs.

In summary, Alternatives 1, 2, 3 and 6 are superior to Alternatives 4 and 5 from a transportation perspective. Factors analyzed include vehicle miles traveled, trip lengths, accessibility to jobs, regional mode split for work trips by transit and CBD transit mode split. Considering all these factors, Alternative 6 emerges as the most efficient alternative. Alternatives 4 and 5 are the least efficient. It should be emphasized that this analysis considers only the relative differences of alternatives with respect to their effect on transportation in the region. It is not possible, using this approach, to determine whether future transportation needs will adequately be met under any particular alternative. To make this assessment, further analysis is required.

THE TRIMS MODEL RUN: BACKGROUND

The Transportation Integrated Modeling System (TRIMS) is a sketch-planning tool which allows rapid estimation of overall demand for travel. It was used to determine total VMT for each of the six alternatives.

It should be noted that the highway network used in the TRIMS runs was constant over all six alternatives. The highway network used was the existing 1975 network, plus some freeways currently under construction. The transit network used was all-bus transit network which existed in 1975. The effect of using the same network for all six alternatives was to remove the transportation system as a determinant of trip volumes; the VMT for each alternative results solely from the location of households and jobs.

The assignment of traffic to the TRIMS network was a capacity unrestrained assignment -- that is, the model assumed that traffic continued to flow

TABLE 32

YEAR 2000 HOME-BASED WORK TRIP MODE SPLITS
(Percent of Total Trips in Year in Parenthesis)

Mode	1970 Base	Alternative					
		1	2	3	4	5	6
Auto Person Trips	2378649 (91.8)	3672455 (94.1)	3726216 (94.1)	3722392 (94.1)	3711065 (95.1)	3717147 (94.6)	3677189 (94.1)
Transit Passenger Trips	211852 (8.2)	231281 (5.9)	234039 (5.9)	233743 (5.9)	189372 (4.9)	214208 (5.4)	230772 (5.9)
Total Person Trips	2590501 (100.0)	3903736 (100.0)	3960255 (100.0)	3956135 (100.0)	3900437 (100.0)	3931355 (100.0)	3907961 (100.0)

NB: Figures based on existing 1975 highway network with freeways under construction added; and on 1975 existing all-bus transit system.

TABLE 33

YEAR 2000 MODE SPLIT FOR DETROIT CBD HOME-BASED WORK TRIPS

(Percent of Total Trips in Year in Parenthesis)

Mode	1970 Base	Alternative					
		1	2	3	4	5	6
Auto Person Trips	158647 (82.4)	261877 (85.4)	266080 (85.8)	264693 (85.5)	249679 (88.0)	260793 (86.5)	260838 (85.4)
Transit Passenger Trips	33972 (17.6)	44616 (14.6)	43890 (14.2)	44891 (14.5)	34108 (12.0)	40701 (13.5)	44454 (14.6)
Total Person Trips	192619 (100.0)	306493 (100.0)	309970 (100.0)	309584 (100.0)	283787 (100.0)	301494 (100.0)	305292 (100.0)

19

NB: Figures based on existing 1975 highway network with freeways under construction added; and on 1975 existing all-bus transit system.

TABLE 34

YEAR 2000 TOTAL VEHICLE TRIP TABLE
(Per Cent of Total Trips in Year in Parenthesis)

Trips	1970	Alternative					
	Base	1	2	3	4	5	6
<u>SUBURBAN TRIPS TO:</u>							
City of Detroit Core Area ¹	187340 (3.6)	307623 (3.2)	320103 (3.3)	310591 (3.2)	325344 (3.2)	320974 (3.2)	303600 (3.2)
City of Detroit Excluding ² Core	735958 (14.1)	823232 (8.6)	850139 (8.8)	839501 (8.8)	786836 (7.9)	794716 (8.0)	824296 (8.7)
Suburbs	4286957 (82.3)	8387056 (88.1)	8482244 (87.9)	8436275 (88.0)	8973026 (89.0)	8781693 (88.7)	8338020 (88.1)
TOTAL	5210255 (100.0)	9517911 (100.0)	9652486 (100.0)	9586367 (100.0)	10085206 (100.0)	9897383 (100.0)	9465916 (100.0)
<u>CITY OF DETROIT TRIPS TO:</u>							
City of Detroit Core Area	287499 (12.6)	309623 (15.2)	311990 (15.1)	319294 (15.2)	251206 (15.6)	286672 (15.9)	318877 (15.1)
City of Detroit Excluding Core	1305212 (57.3)	1024626 (50.4)	850139 (41.3)	1067493 (50.7)	756413 (49.3)	888478 (49.1)	1068666 (50.7)
Suburbs	686892 (30.1)	700500 (34.4)	896908 (43.6)	720228 (34.2)	567201 (35.1)	632741 (35.0)	721970 (34.2)
TOTAL	2279553 (100.0)	2034749 (100.0)	2059037 (100.0)	2107015 (100.0)	1314820 (100.0)	1807891 (100.0)	2109513 (100.0)

¹Includes CBD, Medical Center, Cultural Center, New Center and adjacent areas.

²Includes Highland Park, Hamtramck, and the Grosse Pointes.

NB: Figures based on existing 1975 highway network with freeways under construction added; and on 1975 existing all-bus transit system.

freely no matter how much traffic was assigned to a given facility: there was no congestion-related limitation on travel.

TRIMS is a useful tool for overall travel forecasting, and has produced results for 1975 within five percent of actual regional VMT, taken from SEMCOG highway monitoring files. As a regional sketch-planning tool, TRIMS does not provide analysis for small geographic areas. Therefore, no VMT figures are provided at a sub-county level from the TRIMS run. Because of this macro-scale orientation, TRIMS results should be viewed as measures of the relative differences between alternatives and not as absolute predictions of future travel by facility.

TRANSPORTATION SYSTEM COSTS: RESULTS

Once overall vehicle miles of travel (VMT) figures were calculated for each of the six alternatives, the cost of constructing a system to meet the travel demand was estimated for each of the alternatives.

The first basic element of the total cost was the cost of constructing the new freeways proposed as part of each alternative. Those freeways are illustrated in Table 35.

The lane-miles of arterials that would be needed to handle VMT not handled by freeways were calculated and costed for each alternative. These lane-miles were calculated based on VMT per lane mile from the 1975 Highway Monitoring File. Levels of service were assumed to remain constant over the next 25 years -- that is, enough lane-miles of arterials were added to insure that traffic congestion did not exceed 1975 levels.

Table 36 displays total highway right-of-way and construction costs for each alternative, by county. Alternative 4, which showed the highest VMT, has the highest highway capital costs. Alternative 1 has the lowest capital costs, followed by 2 and 6.

Once capital costs were known, maintenance costs, both for the existing system and the additions to the system were estimated. The maintenance and reconstruction costs of the existing system remain constant over all alternatives. However, maintenance costs for new facilities vary according to the amount of new construction in each alternative. These costs are tabulated in Table 37.

Transit capital costs were added to all alternatives except Alternative 4. These costs were based on completion of the 1990 Transit Plan by 2000, and include only rail system costs; the capital costs of expanding existing bus service were excluded.

Table 38 summarizes the transportation costs that vary under the six alternatives. The costs of maintaining and reconstructing the existing system, a constant of \$7111.88 million, are not included in the table.

Alternative 1 is the least expensive alternative. Even with no expenditures for transit, the heavy highway investments required under Alternative 4 make it rather costly. Alternative 5, with extensive highway

TABLE 35

FREEWAY ADDITIONS

Network	Alternative					
	1	2	3	4	5	6
1970						
1975	Jeffries	Jeffries	Jeffries	Jeffries	Jeffries	Jeffries
1980	I-696 M-14 I-275	I-696 M-14 I-275	I-696 M-14 I-275	I-696 M-14 I-275	I-696 M-14 I-275	I-696 M-14 I-275
1985	M-53 M-21 M-275	M-21	M-53 M-21 M-275	M-53 M-21 M-275 North- western	M-53 M-21 M-275	M-53 M-21
1990	M-59		M-59	M-59	M-59	
1995				Davison/ Mound E-W Con- nection		
2000						

LIMITS

M-21:-----West from Port Huron through St. Clair County.
 M-53:-----From I-696 - 18 Mile Road.
 M-59:-----East from Mound Road to I-94.
 M-275:-----From I-96 to I-75.
 Northwestern:-----Northwestern Highway from I-696 to M-275.
 Davison/Mound:-----Davison from the Lodge to I-96.
 East-West Connector:--South of Metropolitan Airport, from I-275 to I-75.
 Jeffries:-----Grand River to M-275.
 I-696:-----Telegraph to I-94.
 M-14:-----M-275 - M-14 extension.
 I-275:-----I-75 to I-696.

TABLE 36

TOTAL HIGHWAY CAPITAL COSTS

(All Costs are in 1976 Dollars)

Jurisdiction	FREEMWAY CONSTRUCTION AND ROW (1,000,000)					
	Alternative					
	1	2	3	4	5	6
Detroit	9.10	9.10	9.10	40.10	9.10	9.10
Wayne*	394.00	394.00	394.00	454.33	394.00	394.00
Oakland	249.10	24.80	249.10	330.55	249.10	24.80
Macomb	236.00	17.00	236.10	236.10	236.10	125.60
Washtenaw	64.00	64.00	64.00	64.00	64.00	64.00
Monroe	14.70	14.70	14.70	14.70	14.70	14.70
St. Clair	94.40	141.70	94.40	188.72	188.72	141.70
TOTAL	1,061.30	665.30	1,061.40	1,328.50	1,155.72	773.90

Jurisdiction	ARTERIAL CONSTRUCTION AND ROW (1,000,000)					
	Alternative					
	1	2	3	4	5	6
Detroit	297.81	342.39	341.62	135.82	168.40	325.40
Wayne*	1,323.39	1,537.29	1,415.46	920.70	1,248.20	1,260.20
Oakland	2,651.22	2,969.91	2,561.22	2,602.10	3,592.70	3,279.50
Macomb	1,060.71	1,128.09	1,003.47	1,735.50	1,109.30	1,079.80
Washtenaw	1,045.61	1,003.47	1,168.81	1,138.30	1,266.30	1,002.10
Monroe	922.88	828.63	804.87	1,459.10	892.80	763.20
St. Clair	422.14	517.73	368.42	1,362.50	638.10	444.20
Livingston	580.92	1,081.59	1,713.06	1,957.80	1,900.30	1,174.50
TOTAL	8,304.68	9,409.10	9,376.93	11,311.82	10,816.10	9,328.90

NB: Livingston County has no freeways proposed.

* Outside Detroit

TABLE 36 (continued)

Jurisdiction	TOTAL CONSTRUCTION AND ROW (\$1,000,000)					
	Alternative					
	1	2	3	4	5	6
Detroit	306.91	351.49	350.72	175.92	177.50	334.50
Wayne	1,717.39	1,931.29	1,809.46	1,375.03	1,642.20	1,654.20
Oakland	2,900.32	2,994.71	2,810.32	2,932.65	3,841.80	3,304.30
Macomb	1,296.71	1,145.09	1,239.57	1,971.60	1,345.40	1,205.40
Washtenaw	1,109.61	1,067.47	1,232.81	1,202.30	1,330.30	1,066.10
Monroe	937.58	843.33	819.57	1,473.80	907.50	777.90
St. Clair	516.54	659.43	462.82	1,551.22	826.82	585.90
Livingston	580.92	1,081.59	1,713.06	1,957.80	1,900.30	1,174.50
TOTAL	9,365.98	10,074.40	10,438.33	12,640.32	11,971.82	10,102.80

TOTAL CONSTRUCTION AND ROW (1,009,000)

Alternative					
1	2	3	4	5	6
9,365.98	10,074.40	10,438.33	12,640.36	11,971.82	10,102.80

TABLE 37

ESTIMATED MAINTENANCE COSTS
(New Construction Only)

YEAR 2000 MAINTENANCE COSTS FREEWAY & ARTERIAL (\$1,000,000)						
Jurisdiction	Alternative					
	1	2	3	4	5	6
Detroit	0.62	0.71	0.71	0.32	0.34	0.67
Wayne*	3.33	3.80	3.54	2.51	3.17	3.19
Oakland	6.12	7.51	5.67	6.09	8.18	7.24
Macomb	3.21	3.17	2.46	4.08	2.70	2.53
Washtenaw	2.81	1.96	4.02	3.22	3.45	2.28
Monroe	2.68	2.17	2.63	2.58	1.98	1.69
St. Clair	1.96	1.85	1.72	3.20	1.61	1.58
Livingston	<u>2.53</u>	<u>2.38</u>	<u>3.78</u>	<u>4.31</u>	<u>4.60</u>	<u>3.15</u>
TOTAL	23.26	23.55	24.53	26.31	26.03	22.33

NB: Assumed interest rate 6% was used to calculate present worth of maintenance costs.

*Outside Detroit

30-YEAR MAINTENANCE COSTS, 1970 - 2000

	Alternative					
	1	2	3	4	5	6
1975\$	148.67	150.59	156.85	168.22	166.43	142.79
1976\$	161.01	163.10	169.87	182.18	180.24	154.64

TABLE 38

TOTAL COST OF TRANSPORTATION IMPROVEMENTS BY ALTERNATIVE

(Costs are Millions of 1976 Dollars)

Alternative Number	Name	Freeway and Arterial Construction and ROW Costs	Transit* Capital Costs	Highway Maintenance Cost	Total Freeway Arterial, Construction and Maintenance and Transit Costs	Rank
1	Local plans, modified by trends in local policy changes.	9,366.08	2,363.65	161.01	11,890.74	1
2	Local plans, modified by strong resource conservation policies.	10,074.40	2,363.65	163.10	12,601.15	2
3	Local plans, modified by county plans and or policies.	10,438.33	2,363.65	169.87	12,971.85	5
4	Market forces unrestrained.	12,640.36	0	182.18	12,822.54	4
5	Local plans, unmodified.	11,971.82	2,363.65	180.24	14,515.71	6
6	Local plans, modified by adopted SEMCOG policy recommendations.	10,102.80	2,363.65	154.64	12,621.09	3
*Includes fixed facilities vehicles.						

investments as well as transit investments, is most expensive.

DERIVATION OF TRANSPORTATION SYSTEM COSTS

Cost estimates for the various transportation expenditures were prepared using the Characteristics of Urban Transportation Systems (CUTS) Manual developed for the Urban Mass Transportation Administration by DeLeuw, Cather and Company. The CUTS manual is a reference source for values of certain parameters in typical urban transportation systems. CUTS supplied the figures used to estimate the costs of land acquisition, construction, reconstruction, maintenance, and rail vehicle acquisition under each alternative.

Estimates of lane-miles of new facilities needed were based on actual counts of 1975 VMT per lane-mile for the Southeast Michigan region.

FOOTNOTES: CHAPTER IV

¹TRIMS (Transportation Integrated Modeling System) was developed by the staff of the Metropolitan Washington Council of Governments. Application of TRIMS to the Southeast Michigan region is documented in the report: Calibration and Evaluation of the Use of the TRIMS Package for Southeast Michigan by Smith and Richardson, Southeast Michigan Council of Governments, July, 1977.

APPENDIX A

DEVELOPMENT OF COMMUNITY GROUPS

APPENDIX A

DEVELOPMENT OF COMMUNITY GROUPS

The Small Area Forecast model operates at the analysis zone level. This level of detail (there are 1446 of them in the region) is too great for purposes of policy analysis. Accordingly, several higher levels of aggregation are employed in this document. Zones are summed to Minor Civil Division in Appendix B. In the body of the report, Minor Civil Divisions are summed to the county level.

The purpose of county aggregations is obvious. Counties are a generally accepted and widely used large scale unit for examining change in the region. However, county level aggregations may in some cases mask changes at the sub-county level. For example, under a given alternative a county might have a net change from the years 1970 to 2000 of zero households. This net change could be composed of a loss of households in large cities, no change in suburban areas, and a gain of households in previously rural areas.

To account for such a situation, a grouping of communities into seven categories has been developed. Communities within each group have some similar characteristics based on 1970 data. Since the policies expressed in a single alternative are consistent throughout the region, similar results tend to be seen in communities which have similar characteristics, regardless of their location in the region. Thus, the groupings will show changes to communities with relatively similar circumstances, regardless of their county -- changes which can be masked by county-level summaries.

Table A-1 summarizes the specific criteria used to define each group. In this grouping, cities and villages are grouped separately from townships. Within the cities and villages, they are grouped according to population and percent "built-up", which is a measure of how fully developed the community was in 1970.

- Group 1 consists of populous cities with relatively little remaining vacant land which could be developed.
- Group 2 consists of populous cities which still have a significant amount of vacant land that could be developed.
- Group 3 consists of less populous cities and villages with relatively little remaining vacant land which could be developed.

TABLE A-1

COMMUNITY GROUP CLASSIFICATION

Community Group	Government	1970 Population	1970 Percent Built-Up	Sewered Holding Capacity 1970
Group 1	Cities and Villages	15,000+	81-100	-
Group 2	Cities and Villages	15,000+	0-80	-
Group 3	Cities and Villages	0-15,000	81-100	-
Group 4	Cities and Villages	0-15,000	0-80	-
Group 5	Townships	10,000+	-	-
Group 6	Townships	0-10,000	-	0-450
Group 7	Townships	0-10,000	-	450+

TABLE A-2

COMMUNITY GROUPS BY COUNTY

County	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Total
Detroit	1	-	-	-	-	-	-	1
Out-Wayne	14	7	5	7	4	0	5	42
Oakland	7	5	6	20	9	10	2	59
Macomb	5	1	2	8	3	3	5	27
Washtenaw	1	1	1	4	2	10	8	27
Monroe	0	1	1	7	3	10	2	24
St. Clair	1	0	0	8	0	15	8	32
Livingston	<u>0</u>	<u>0</u>	<u>1</u>	<u>3</u>	<u>0</u>	<u>13</u>	<u>3</u>	<u>20</u>
TOTAL	29	15	16	57	21	61	33	232

Group 4 consists of less populous cities and villages which still have a significant amount of vacant land that could be developed.

Within the township groups, communities are grouped by population and sewer holding capacity in 1970, which is a measure of how much investment in sewers existed at the beginning of the forecast process.

Group 5 consists of townships which are populous, regardless of other characteristics.

Group 6 consists of less populous townships without significant investments in sewer in 1970.

Group 7 consists of less populous townships which had significant sewer investments in 1970.

A distribution of the number of communities in each group by county is presented in Table A-2. Table A-3 lists all communities in the region and gives the characteristics on which the grouping was based. Finally, Figure A-1 is a map, showing how the groups distribute over the entire region.

The group to which a community is assigned in no way affects the results for the community. It is simply a display device applied to the results after they are produced, to assist in understanding the results at a regional scale.

FIGURE A-1
COMMUNITY GROUPINGS FOR SAF EVALUATIONS

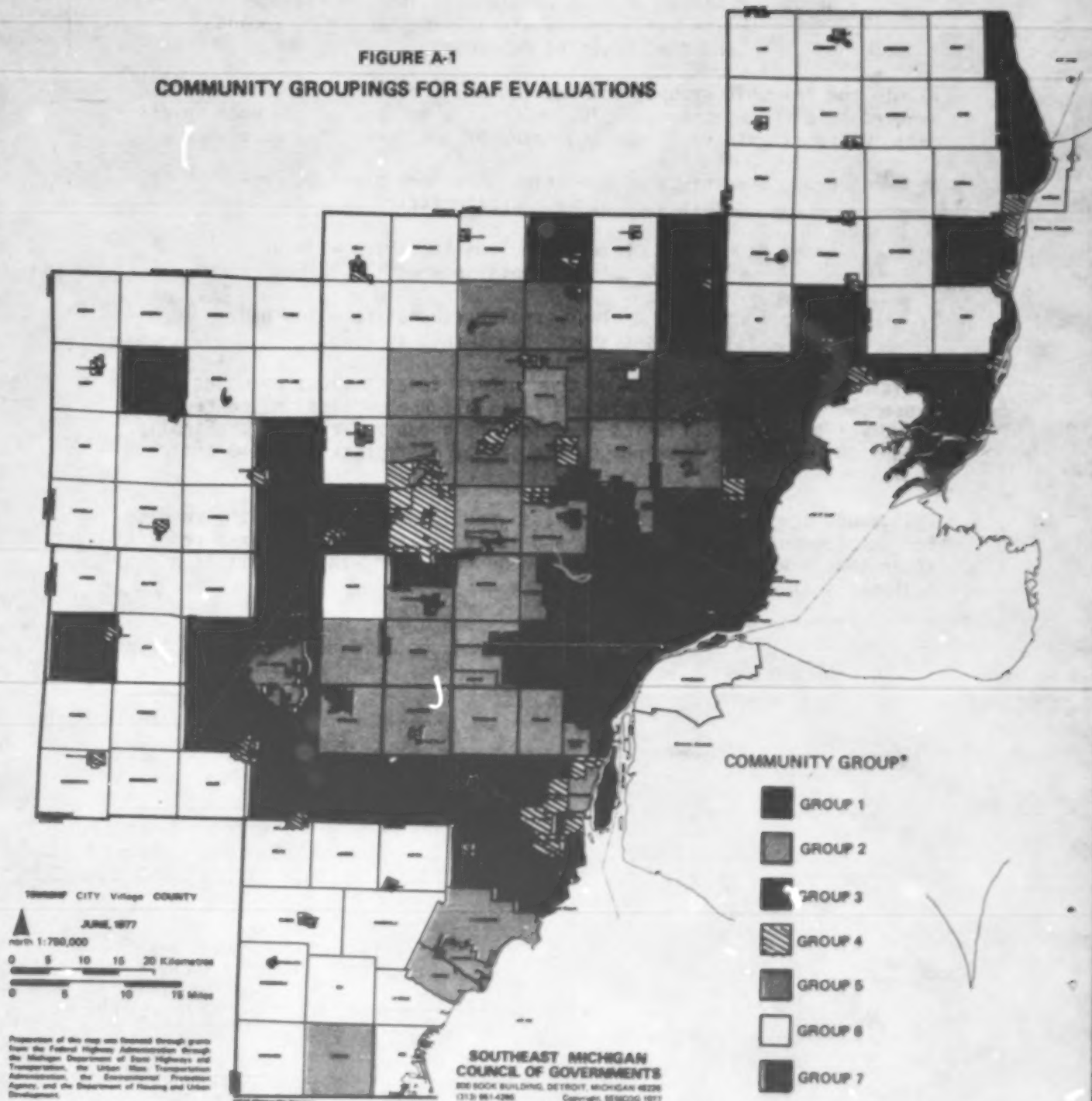


TABLE A-3

LIST OF MINOR CIVIL DIVISIONS BY COMMUNITY GROUP

GROUP 1

Community	1970 Population	Percent Developed 1970
Allen Park	40690	83
Berkley	22618	100
Birmingham	26181	87
Clawson	17631	95
Dearborn	103988	81
Dearborn Heights	80083	95
Detroit	1510395	92
East Detroit	45881	99
Ecorse	17523	97
Ferndale	30763	99
Garden City	41901	90
Grosse Pointe Park	15535	100
Grosse Pointe Woods	21621	97
Hamtramck	27257	98
Harper Woods	20342	98
Hazel Park	23680	100
Highland Park	35444	98
Inkster	38548	87
Lincoln Park	52966	93
Mt. Clemens	20338	87
Oak Park	36665	98
Port Huron	38799	86
River Rouge	15919	93
Roseville	60436	81
Royal Oak	85564	97
St. Clair Shores	87941	92
Warren	178624	82
Wyandotte	40969	96
Ypsilanti	26864	84

continued

TABLE A-3 (continued)

GROUP 2

Community	1970 Population	Percent Developed 1970
Ann Arbor	102603	74
Farmington Hills	50047	30
Livonia	109757	62
Madison Heights	38392	79
Monroe	20407	54
Pontiac	84789	65
Romulus	22507	38
Southfield	68823	73
Southgate	33904	64
Sterling Heights	61128	38
Taylor	69997	54
Trenton	24037	73
Troy	38892	41
Wayne	21061	72
Westland	86556	61

GROUP 3

Beverly Hills	13599	84
Centerline	10392	92
Clarkston	1048	98
Dexter	1686	84
Grosse Pointe	6599	100
Grosse Pointe Farms	11690	99
Grosse Pointe Shores (part)	148	90
Grosse Pointe Shores (part)	2886	91
Howell	5224	81
Huntington Woods	8243	100
Lathrup Village	4346	89
Melvindale	13784	89
Petersburg	1422	84
Pleasant Ridge	3989	100
Plymouth	11786	85
Rochester	7019	94

continued

TABLE A-3 (continued)

GROUP 4

Community	1970 Population	Percent Developed 1970
Algonac	3684	65
Armada	1423	48
Belleville	2421	48
Bingham Farms	703	30
Bloomfield Hills	3672	49
Brighton	2634	61
Capac	1060	44
Carleton	1555	39
Chelsea	3939	57
Dundee	2700	59
Emmett	248	13
Estral Beach	486	34
Farmington	12059	76
Flat Rock	5680	22
Fowlerville	2141	45
Franklin	3157	67
Fraser	11868	56
Gibraltar	3322	22
Holly	4355	42
Keego Harbor	3092	75
Lake Angelus	586	58
Lake Orion	2892	47
Leonard	337	20
Luna Pier	1397	40
Manchester	1645	37
Marine City	4567	70
Novi	5611	55
Novi	564	23
Memphis (part)	867	43
Memphis (part)	309	47
Milan (part)	3775	83
Milan (part)	822	33
Milford	4664	43
New Baltimore	3868	28
New Haven	1871	23
Northville (part)	3033	79
Northville (part)	2263	55
Novi	9827	13
Orchard Lake	1427	70
Ortonville	963	79
Oxford	2536	57
Pinckney	739	19
Richmond	3059	42

continued

TABLE A-3 (continued)

GROUP 4 (continued)

Community	1970 Population	Percent Developed 1970
Riverview	11342	54
Rockwood	3125	31
Romeo	4016	68
Saline	4811	54
South Lyon	2675	44
South Rockwood	1420	40
St. Clair	4770	62
Sylvan Lake	2075	36
Utica	3504	74
Walled Lake	3880	44
Wixom	2004	20
Wolverine Lake	3914	52
Woodhaven	3258	28
Yale	1447	64

GROUP 5

Community	1970 Population	Sewered Holding Capacity 1970
Avon Township	24361	4895
Bedford Township	20839	14239
Bloomfield Township	42554	3233
Canton Township	10987	29546
Clinton Township	48888	22994
Commerce Township	14788	0
Frenchtown Township	14637	3753
Harrison Township	18669	8064
Independence Township	16192	1181
Monroe Township	12883	7269
Orion Township	14202	673
Plymouth Township	17486	5407
Pontiac Township	12359	2176
Redford Township	71951	743
Shelby Township	29300	10117
Superior Township	10235	11899
Van Buren Township	13083	16181
Waterford Township	58898	8458
West Bloomfield	28489	13813
White Lake Township	14293	0
Ypsilanti Township	29855	18073

continued

TABLE A-3 (continued)

GROUP 6

Community	1970 Population	Sewered Holding Capacity 1970
Addison Township	2471	0
Armada Township	1604	0
Berlin Township SC	1361	0
Brandon Township	3850	0
Bridgewater Township	1068	0
Brockway Township	1076	0
Casco Township	1926	139
China Township	1851	0
Clyde Township	4745	0
Cohoctah Township	1546	0
Columbus Township	1930	200
Conway Township	1121	0
Deerfield Township	1269	0
Dexter Township	2317	0
Dundee Township	2209	194
Emmett Township	803	0
Erie Township	4517	0
Exeter Township	2406	0
Freedom Township	1354	0
Genoa Township	4623	0
Grant Township	845	0
Greenwood Township	996	0
Groveland Township	2571	0
Hamburg Township	5481	0
Handy Township	1488	0
Hartland Township	2822	0
Highland Township	8372	0
Holly Township	3042	0
Ida Township	3377	0
Iosco Township	738	0
Kenockee Township	697	0
Kimball Township	5965	0
LaSalle Township	4155	0
Lima Township	1194	38
London Township	2522	0
Lyndon Township	1211	0
Lynn Township	920	0
Manchester Township	1097	0
Marion Township	2430	0
Milan Township	1830	80
Milford Township	2591	0
Mussey Township	2228	0
Oakland Township	4794	0
Oceola Township	2964	216
Putnam Township	2616	0

continued 86

TABLE A-3 (continued)

GROUP 6 (continued)

Community	1970 Population	Sewered/Holding Capacity 1970
Ralsinville Township	4009	270
Ray Township	2685	0
Richmond Township	1682	0
Riley Township	1237	0
Rose Township	2506	0
Royal Oak Township	6294	0
Salem Township	3004	0
Saline Township	1280	85
Sharon Township	808	0
Springfield Township	4386	0
Summerfield Township	2420	264
Tyrone Township	3187	0
Unadilla Township	2111	0
Wales Township	886	0
Webster Township	2943	312
Whiteford Township	4056	0

GROUP 7

Ann Arbor Township	1730	4040
Ash Township	4250	1766
Augusta Township	4378	2770
Berlin Township MN	3605	2342
Brighton Township	5882	603
Brownstown Township	7078	18226
Bruce Township	2191	493
Burtchville Township	1807	660
Chesterfield Township	9340	17764
Clay Township	6438	4695
Cottrellville Township	2014	1443
East China Township	2103	2894
Fort Gratiot Township	6184	5234
Green Oak Township	7597	1172
Grosse Ile Township	7799	4675
Howell Township	2357	792
Huron Township	8028	9201
Ira Township	3644	4104
Lenox Township	2869	1551
Lodi Township	1626	1655
Lyon Township	4498	2043
Macomb Township	5846	15758
Northfield Township	3575	2834
Northville Township	9443	7495

continued

TABLE A-3 (continued)

GROUP 7 (continued)

Community	1970 Population	Sewered/Holding Capacity 1970
Oxford Township	5954	607
Pittsfield Township	8820	14271
Port Huron Township	5560	3139
Scio Township	3675	12658
St. Clair Township	3592	1695
Sumpter Township	8092	468
Sylvan Township	1651	1207
Washington Township	5671	8057
York Township	5680	809

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The Southeast Michigan Council of Governments (SEMCOG) is a voluntary association of governments composed of elected officials from member communities in Southeast Michigan. SEMCOG develops and coordinates regionwide planning for transportation, land use, recreation and open space, water quality management, housing and criminal justice. For further information concerning this report or the Council, please contact the Council's Information Services Office, (313) 981-4266.

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